Presented to

J. C. Russe[illegible]

By N. H. WINC

State Geolo

On behalf of the Regents of the Univers

Contributions to the Museum and Libr

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N. H. WINCHELL, State Geol
S. F. PECKHAM, -
M. D. RHAME, - -
P. L. HATCH, - -
ALLEN WHITMAN, -
CLARENCE L. HERRICK,

Submitted to the President

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THE BOARD OF REGENTS OF THE UNIVERSITY.

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

THE SIXTH ANNUAL REPORT

FOR THE YEAR 1877.

OFFICERS OF THE SURVEY:

N. H. WINCHELL, State Geologist,	In Charge.
S. F. PECKHAM,	Chemistry.
M. D. RHAME,	Topography.
P. L. HATCH,	Ornithology.
ALLEN WHITMAN,	Entomology.
CLARENCE L. HERRICK,	Laboratory Assistant.

Submitted to the President of the University, May 25, 1878.

MINNEAPOLIS:
JOHNSON, SMITH & HARRISON.
1878.

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1877.

To the President of the University :

DEAR SIR—I have the honor to offer, and to transmit through you to the Board of Regents of the State University, the Annual Report required by law on the progress of Geological and Natural History Survey of the State, being the sixth since the beginning of the survey.

Very respectfully, your obedient servant,

N. H. WINCHELL.

STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

1. *Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey. 34 pp., 1860. Reprint from the Wisconsin Reports for 1858. Out of print.*
2. *Statistics and History of the Production of Iron, by A. S. Hewitt. 47 pp., 1860. Reprint of a paper read before the American Geographical and Statistical Society, January 31, 1856. Out of print.*
3. *Report of Anderson and Clark, Commissioners on the Geology of the State, January 25, 1861. 8vo. 26 pp. Out of print.*
4. *Report of Hanchett and Clark, November, 1864. 8vo. 82 pp. Out of print.*
5. *Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior. 1866. 8vo. 23 pp.*
6. *Report of H. H. Eames on some of the northern and middle counties of Minnesota. 1866. 8vo. 58 pp. Out of print.*
7. *Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota. 1866. 8vo. 52 pp., close type, with wood cuts.*
8. *Report of N. C. D. Taylor on the Copper District of Kettle River, incoporating Mr. James Hall's estimate of the copper prospects of that district. 1866. 2 pp. 8vo. Found only in the Executive Documents.*
9. *Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June 17, 1871. 8vo. 16 pp.*
10. *The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp., with a colored geological map of the State. Published in the Regents' Report for 1872. Out of print.*
11. *The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.*
12. *The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo., with two county maps. Published in the Regents' Report for 1874.*
13. *The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington. 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.*
14. *The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson; 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.*

[NOTE.—Of the foregoing, Nos. 1, 2, 4 and 6 are wanted by the Survey.]

REPORT.

I.

SUMMARY STATEMENT.

The Regents having authorized a joint examination with the State Board of Health of the water supply for domestic uses in the Red River valley, the first work undertaken in the season of 1877 was an attempt to ascertain the cause or causes of the unwholesome water often found in common wells throughout the valley of that river. About four weeks were spent in that part of the State, the observations extending from Breckenridge, the present terminus of the St. Paul & Pacific Railroad, to Winnipeg in Manitoba. The details and the results of this examination will be found in the following pages. It is sufficient here to say that the chief cause of the "stagnant," or foul water so common in wells of that part of the state was found to be the almost universal practice of curbing wells with pine wood; and that there is nothing in the water itself which is unwholesome or injurious. It is true that wells from the drift-clay are apt to be more or less alkaline, unless from extensive gravel or sand beds within the clay, but there is no reason, except artificial or unnatural causes, why the water of that part of the State should become foul or "stagnant" in common wells, any sooner or more frequently than in any other equally clayey portion of the northwest. It was found, indeed, later in the season, that this difficulty is by no means confined to the valley of the Red River of the North. It is encountered with equal frequency throughout the entire western half of the State, from the Iowa line northward to Manitoba, and must be referred to some cause that is not local in its application. In the absence of stone for walling their wells, the

early settlers of the prairies, who have been generally men of little pecuniary means, have resorted to the use of pine plank for curbing them, on account of its availability and cheapness, and to this practice may be attributed by far the greater portion of the difficulty, resulting in many cases of sickness (usually typhoid fever) and many deaths. This fact cannot be too widely published, nor its pernicious effects on the general health and prosperity of the newly settled counties too strongly impressed on the people.

Reconnoissances into different parts of the state have been made during the season, having different objects in view, viz.: one into Wright county for the examination of localities of reputed "coal" outcrop; one into Rice county preparatory to the survey of the county by Prof. L. B. Sperry; one into Goodhue county preparatory to the full examination of that county during the coming season; one over the line of the Northern Pacific railroad supplementary to the water-examinations of the Red River valley earlier in the season, and for geological observations, and one into Morrison county for the purpose of preliminary geological observations. The results of these reconnoissances are given in the following report, so far as they can be made useful at the present stage of the survey.

In the survey of Hennepin county it was found necessary to embrace some parts of Ramsey, and during the past season the survey of that county was completed, and is herewith reported, with the usual maps and diagrams.

Rock and Pipestone counties, the most southwesterly in the State, have also been examined, and are reported in the same manner.

Rice county has also been surveyed in detail by Prof. L. B. Sperry of Northfield College, and his report on the same is herewith transmitted.

Further examination of the fossils of the Trenton was carried on during the intervals of interruption of the field-work, and some further notes on the same are given in the following pages. It cannot be expected, however, that while the field-work is steadily carried on the detailed laboratory work of palaeontology and lithology will progress with equal pace without the employment of extra assistance. Still such progress as is possible will be reported from time to time.

There is, accompanying this, a detailed report on the General Museum for the year 1877, showing the addition of minerals, and specimens of foreign rocks, as well as the naming of fossils in the cases of the Museum. There is work enough now on hand, in the Museum, to require the steady work of a man a whole year, with

nothing else to do. It cannot be impressed to strongly on the Regents that there is a necessity of employing more assistance, or of the curtailment of some of the labor now devolving on a single man. It is certainly very necessary that the Museum be placed in its best condition. This implies the working up of many boxes of material, both in mineralogy and lithology, and in palaeontology. This is nearly all within the purview of the geological survey of the State, the material being almost all the product of the field examinations, and would redound to its substantial progress perhaps to a greater extent than the continued and constant prosecution of the field-work.

The report of Prof. Peckham on the chemical analyses of various substances submitted in the progress of the field-work is also included in the following pages; also, that of Dr. P. L. Hatch on the investigations he has prosecuted during the year on the ornithology of the State.

The year has been signalized by the disappearance from the State, and from the entire Northwest, of the Rocky Mountain Locust. The interesting and important report of Mr. Whitman on the phenomena and causes of such disappearance, and on other insects injurious to farm products still existing within the borders of Minnesota, is also transmitted herewith.

In Botany, while there has been a steady increase of specimens, gathered by Mr. Herrick, or presented by other collectors, there has been no attempt at classification or thorough examination. The progress of the work in this field will be mainly in the gathering of material, for several years; but finally the aid of expert botanists will have to be obtained in the preparation of a final report.

The officers of the Northern Pacific and of the St. Paul & Duluth Railroads very courteously furnished the State Geologist with passes over their roads while engaged in the northern part of the State, and those of the St. Paul & Pacific and of the Red River Transportation Company extended the same favors during the progress of the survey of the Red River water supply.

A considerable portion of the season has been spent in the northern half of the State. What has been done there has been of the nature of hasty reconnoisances. Nothing else is possible. The means now available for the survey will not warrant the commencement of detailed surveys in a region mainly without roads and but sparsely inhabited, however great the need of geological examination. It is mainly for this reason that the survey has been carried on during the past six years in the southern portion, where, at much less expense, the utility of the survey could be demonstrated

and its progress be more evident; as it is well known that geological surveys have, in various states, come to unfortunate interruption, and sometimes final termination, for causes immediately political or economical. The time has come, however, when it will not be prudent nor just to further ignore the northern half of the State. An unusual impetus in immigration, and in prospective mining, has stirred the people in that part of the State, during the past year, to make serious demands for the services of the Geological Survey in exploring and developing their material resources. The enterprise of the government of the Dominion of Canada on our northern frontier, in the building of railroads and canals, will not fail to react powerfully on the State of Minnesota north of Lake Superior. The Canadian geologists have already visited and reported a number of times on the contiguous portions of the British Possessions. It seems to be very necessary to subject that part of the State to a thorough geological survey; but it will require expensive outfits for two or three exploring parties, and it would be several years before the survey could progress sufficiently to warrant a final report. Meantime, during the progress of the work in the northern part of the State, investigations should not be suspended in the southern portion. In order to carry on the survey now as it seems to be necessary, an additional sum of six or eight thousand dollars per annum, for about four years, should be available. It would then be possible, probably, to issue a couple of volumes of a final report, one on the southern palæozoic formations, and one on the metamorphic and azoic rocks of the northern portion of the State.

II.

THE WATER SUPPLY OF THE RED RIVER VALLEY.

The State law by which the survey is being carried on requires a complete account of the mineral and other waters of the State, including accurate chemical analyses. It was at the instance of the Secretary of the State Board of Health that the immediate examination of this region was undertaken; the sanitary questions involved being regarded of great importance. With a view to the co-operation of the Regents and the State Board of Health in this examination, a joint party was organized, consisting of the State Geologist, with Prof. S. F. Peckham on the part of the Regents, and Dr. C. N. Hewitt, Secretary of the Board of Health. The plan of procedure consisted in a descent of the valley from Breckenridge, on the St. Paul & Pacific Railroad, to Winnipeg, in Manitoba, stopping at the principally settled points for information concerning the objects of the survey, examining all accessible wells and procuring samples of water, and carefully noting the nature of the river bluffs. Subsequently, and during the further prosecution of the field-work over the western portion of the State during the season, more extended observations on the same subject were made by the State Geologist outside of the Red River valley, and the valley itself was again visited for further facts of comparison and verification. The conclusions arrived at in this report are based on all the facts observed; and as they vary somewhat from opinions advanced by other members of the party, it is but just to relieve them from all responsibility for them. Soon after the return of the party a summary of these conclusions was prepared at the instance of Gov. J. S. Pillsbury, and it was published in the *Pioneer Press* for September 18, 1877.

It is also necessary to state that the samples of water selected for analysis were not such as would test the correctness of these conclusions, nor that of any theory that has yet been advanced for the cause of the foul waters of the Red River valley. In order to determine something by chemical analyses of the waters, the writer selected and urged the full analysis of four samples only, with qualitative tests for other samples to show their relations to either of these, viz.:

1. Some simply alkaline water from a deep well.
2. Alkaline water from some deep well contaminated by organic decay.
3. Water from some shallow well uncontaminated by organic decay.
4. Water from a shallow well foul from organic decay.

The analysis of water from the following wells, conforming to the conditions required by the above varieties of water, was recommended for the purpose of arriving at some satisfactory result. It is to be hoped that the survey may be able at some future time to institute further examination, and chemical analysis, should the explanation here given not prove sufficient.

1. Water from the Brewery at Moorhead.
2. Town well at Breckenridge.
3. McHench's cistern well at Fargo.
4. Well at Mr. Sloggy's house (not the Bramble House.)

The Facts Known Before the Survey.

The flat prairie country generally, throughout the western portion of the State, has been much troubled by bad well water. This has been reported to the survey from Lyon, Renville, Redwood and Murray counties, in the southwestern portion of the State, and had by the parties troubled by bad water been attributed to a so-called "peculiar clay," a "blue clay," a "black clay," or to some other deposit in the drift which had been met with in the wells. Similar reports had come from the country further north, and latterly from the Red River valley specially. The settlement of the Red River valley has been rapidly going on during the past two years, and these difficulties were more numerously and urgently presented from that quarter of the State. As these waters had a very deleterious effect on the health of the people, and threatened to retard the development of that portion of the State, the State Board of Health very wisely initiated the systematic examination of the whole question which is now being made, but directed itself specifically to the valley of the Red River of the North. The waters

from the wells dug, whether deep or shallow, have been found to become foul, or "stagnant," sooner or later, and if their use has continued much beyond the discovery of this condition they have produced diarrhœa of a persistent nature, and finally typhoid fever. Some cases have terminated fatally. These facts were of occurrence on the line of the St. Paul & Pacific Railroad, at nearly all the stations west of the line of the Big Woods, even outside the valley of the Red River; on the Northern Pacific Railroad west of Detroit; along the same railroad in Dakota, and down the valley to Winnipeg. These effects were known also south of the Minnesota river, but they have not been attributed so directly, so far as the writer is aware, to the water used for domestic purposes. Yet typhoid fever and intestinal diseases have had, during the past ten or fifteen years, an area of greatest prevalence in western Minnesota and Iowa, according to the ninth United States census. The ascertained relation of cause and effect between bad well water and these diseases in one section of the State, together with the known existence of the same effect in another section under like conditions of soil, climate and surroundings, reasonably leads to the inquiry whether the same cause has not prevailed there also, though it may not have been so distinctly recognized. Another fact that had been stated and well authenticated before the beginning of the survey, was the good quality of the water when the wells were first dug. It has also been stated that during the construction of the railroads that cross that portion of the State, a number of shallow wells were dug in the surface of the prairie, without reaching much water, and that they often became foul in a few days, though wholly uncurbed.

The Wells that were Visited and Examined.

The following facts were gathered by the writer:

Morris.—At Morris, in Stevens county, which is on the Pomme de Terre river, a tributary of the Minnesota, and not within the valley of Red River, the wells are usually bad, and the people generally use the water of the Pomme de Terre. Wells have to be dug rather deep, and through a blue hard-pan. The railroad company are now boring a well having a diameter of sixteen inches. They turn a sort of auger by a single horse-power, and take out the clay as an auger takes out wood, but it has to be lifted out frequently. The material thrown out, now at the depth of 56 feet, is a blue clay with few stones, but some small gravel. No water has been met with yet.

According to Mr. Leonard B. Hodges a well of good water was obtained at Morris later in the season of 1877. It is owned by Judge L. E. Pierce. It is surrounded by foul wells, several of about the same depth, and others of not half that depth. It is in every respect like many other wells at Morris, except in not having wood curbing. It was "driven," *i. e.,* after digging some depth an iron pipe with protected sieving was driven into the clay till water was found which rose in the pipe. This well was good and has remained so.

St. Gabrielle Springs. NE¼ Sec. 17, T. 130, 45.—Three miles from Campbell station, a little south of east. Here are St. Gabrielle Springs, said to furnish "good water;" but although there is a scummy deposit of iron running from them the water tastes alkaline, and is very much like the water of the deep well at the station. There is a boggy area of about two and a half acres, lying a few feet above the water of the stream (Rabbit river) from which the water of the springs runs into the creek. This area is in a bend of the stream, and lies about six feet below the general level of the prairie. The stream is about twelve feet below the prairie, and empties in Bois des Sioux river. It is a small stream and has clear water, but an imperceptible current. In some of the springs which are scattered over the boggy area mentioned, there is a light-colored sand seen boiling up with the water, and in the sand are also some weathered small shells. The bog itself is peaty, and shows some small fresh-water shells. The banks of the stream show nothing but the usual gray drift-clay, containing boulders of granite and many pieces of limestone. The water of the creek tastes swampy and flat. The stones and the gravel of the drift, along the low bluffs of the creek, are mainly of limerock—perhaps three-fourths of them, the rest being granite, &c.

Over the surface of the prairie about, which is nearly flat, are occasional fragments of limestone, which are usually somewhat imbedded in the surface, showing the *glacier origin* of even the latest part of this flat. There is no loam here, nor stratified fine clay. There is only a gravelly or stony clay that is blackened at the surface. On making a few qualitative tests on the spot on the water of this spring, for comparison with that of the water at Campbell Station coming from the deep well there (next mentioned), it was found to agree, even by actual comparison in hand, almost exactly with the water of that well. They both possess abundant sulphates, carbonates strong, and plenty of chlorides. The only perceptible difference in mineral constituents was a little greater quantity

of iron in the well water. On making quantitative examinations Prof. Peckham reports these waters to contain impurities as follows:

	Total mineral matter.	Organic and Volatile.	Total residue at 30° C.	Removeable Hardness.	Permanent Hardness.	Total Hardness.	Chlorine.	Suphuric Acid.	Lime.	REMARKS.
2.	62.456	12.316	74.764	10.216	15.468	25.684	10.623	4.202	6.647	These waters show a very remarkable similarity of mineral constituents.
3.	55.454	12.481	68.295	8.756	11.960	20.722	No Estimate	5.370	6.864	

As the water at the station is foul and unfit for use, while that from these springs is pronounced good, and even has a reputed excellence, both waters coming through the same natural drift deposit, subject to the same natural causes so far as their source is concerned, while the spring water itself is free from noxious odors, it is evident the difference of the waters cannot be indicated by chemical analyses of the mineral constituents. It is also evident that the difference, whatever its nature or origin, must be superinduced by some *artificial*, and not natural, cause; in other words, that there is something inherent in the well, or its artificial surroundings, that superinduces the noxious odors. The trouble, further, cannot lie in the clay of the drift, since the spring water is constantly in contact with the clay, and the well water is brought up through an iron pipe which is said to run to the bottom.

Campbell Station.—The well at Campbell Station was sunk several years ago by C. E. Whelpley, of Minneapolis. The following section of this well was furnished by him July 19, 1875:

1. Hard yellow clay with strong bitter water 18 feet.
2. Blue clay 53 feet.
3. Boulders, or rock of some sort 4 feet.
4. Blue clay 39 feet.
5. Blue clay, boulder, gravel and flint 11 feet.
6. Sand, gravel and clay, with some coal 21 feet.
7. Sand, gravel, blue clay, slate, some coal 4 feet.
8. Hard blue clay 15 feet.
9. Clean sand with water, mixed with coal (10 per cent.) 8 feet.
   [NOTE—This coal on examination was found to be drift pieces of Cretaceous lignite—N. H. W.]
10. Stony blue clay, but softer below, with more water at the bottom 87 feet.

Total depth 260 feet.

The lower portion of the pipe becoming filled with mud it was found necessary to puncture the pipe at higher levels and admit water above the clay filling. This was done at 176 feet. The water rose within four feet of the surface.

At the depth of 173 feet found wood which was covered with a yellow substance like gold (probable pyrite—N. H. W.) and was heavier than water. Water was obtained at 125 feet, and again at 150 feet, also at 165 feet.

The water pumped out of this well in June, 1877, was turbid with sediment and visible floating particles, and had foul odors. It could not obtain these foul odors from the bottom of the well, nor furnish these floating particles from that depth, since they were evidently both of organic nature. The upper ten or fifteen feet of this well were dug larger than the rest and curbed up with pine boards after the manner of most wells on the prairie.* This was partially filled with water and served as a reservoir. This water must certainly find access within the iron pipe, either through intentional rupturing of the pipe, or loose fitting of the pipe upon the lower joint of the pump. It otherwise passes along the outside of the pipe, between the pipe and the surrounding clay, to the bottom of the well, and is drawn into the pipe at the bottom. This last supposition is hardly possible, as the closeness of the clay about the pipe is probably as perfect as about any stone or boulder, and must be as impervious. Further the surface water would not thus naturally flow downward, being warmer and lighter, as well as being under less hydrostatic pressure, as long as there remained a supply for the pump within the pipe.

About a mile northwest of Herman the railroad passes down a terrace to a lower flat, the change of level being about fifteen feet. Hence the well at Campbell Station, wholly dug in the glacier drift, without any overlying stratified clays, cannot be affected by any lacustrine clay that seems to have been deposited over large areas in other parts of the Red River valley. The glacier drift itself, over wide tracts in this valley, lies at the very surface.

At Breckinridge.—At this place, which is near the junnction of the Otter Tail and Bois des Sioux rivers, the grade of the railroad is just twenty feet lower than at Campbell Station, and a hundred and six feet lower than at Herman Station. The distance from Breckenridge to Campbell Sta-

*On inquiry of Mr. Whelpley concerning this well he affirms that no wooden curbing was used in the shallow preliminary digging, the only design being to get room to enter his pipes, and that the dug part was almost entirely refilled, leaving but a shallow basin round the pipe at the surface.

tion ... is fifteen miles, and from Breckenridge to Herman is thirty-nine miles; the country in all directions being a smooth prairie for many miles, with no visible changes except at the terrace mentioned, near Herman. Yet at Breckenridge, along the river banks, are broken areas of true lacustrine clay. This runs back from the river and covers a small indefinite area. It seems to have been deposited on a slightly uneven upper suface of glacier clay, or unmodified drift, so that it here only occupies the depressions in the glacier clay.

The town has five wells, but only one is used. It is the hotel well, owned by Mr. Sanders, who described it as follows. It is curbed with boards.

Sanders' Well at Breckenridge.

1.	Mucky, black soil, no stones	2½ feet.
2.	Fine clay, without stones; the same as seen in the river banks	16 feet.
3.	Gravel—small pieces of limestone, and granite boulders, with some layers of clean sand	10–12 feet.
4.	Under the last, which furnished water, was an unknown thickness of a black or blue-black clay, that had a different odor. This contained stones and boulders, one of which stopped the further sinking of the well, which, however, did not penetrate it to any considerable depth.	

The water of this well, analyzed by Prof. Peckham, shows the following composition, as reported by the Secretary of the State Board of Health:

	Grains per Gallon.
Total solid matter in solution	86.024
Total organic matter in solution	12.286
Total mineral matter in solution	73.756
Total hardness	19.843 $CaCO_3$
Permanent hardness	8.756
Removable hardness	11.387
Sulphuric acid in solution	1.868
Chlorine	17.395

These results show a general resemblance to those of the well at Campbell Station, and the water of St. Gabrielle Springs, containing nearly the same per cent. of the various mineral peculiarities.

The town well was mainly a bored well, but is curbed with pine boards. The water here varies. Sometimes it has been pretty good, especially at the first, but at the time of this examination it was strongly charged with sulphuretted hydrogen. It is in the

street, and near no sewers. The ground was raised about the mouth of the well to prevent in-drainage from the surface.

Town Well at Breckenridge.

1. Soil and clay.. 4 feet.
2. "Black clay," &c., with gravel stones, no water........... 30 feet.
3. Gravel and sand, with water in abundance, that rose 16 feet in a few minutes.........................Thickness unknown.

On analysis this was found to be a very hard mineral water, containing large percentages of sulphates of lime and magnesia, but "on evaporation had the appearance and odor of urine residue." This water may be taken as a type of the waters derivable from deep wells that penetrate the glacer drift-clay, when not materially changed by contact with organic acids.

The well of Peter Hanson was dug entirely, 3½ feet square, and curbed with pine boards. The material thrown out is unmodified drift-clay, of a dark-blue color, containing stones and boulders, some ten and fourteen inches in diameter, which show smoothly polished and also striated surfaces. The clay itself is nearly black when wet, and is charged with little stones. This well did not pass through the drift clay, and now affords only "seep water," which, after a month or two, will about half fill the well. It then has a foul odor which is attributed to the "black stuff," as the drift-clay is designated.

Peter Hanson's Well at Breekenridge.

1. Clay, as in the river banks; fine and horizontally stratified..4-5 feet.
2. Drift clay, dark colored, hard and strong, no water, penetrated.. 50 feet.

The well of Chas. B. Falley, Esq., is altogether in the lacustrine clay. It afforded pretty good water at first, but in a few days it became offensive.

C. B. Falley's Well at Breckenridge.

1. Black loam soil.......................................4 or 5 feet.
2. Light colored clay, with some sand, without stones, crumbling in the air.................................... 24 feet.
3. Sand with water (17 feet of water)...........Thickness unknown.

From Breckenridge the river was followed in a small row-boat to McCauleyville, opposite Fort Abercrombie, for the purpose of carefully examining the banks.

Section 21, Town 133, Range 47, Wilkin County.—Mr. Edward Connelly has here a well twenty-five feet deep, in which the water rises and falls as the river changes, indicating an intimate connection. The well is near the brink of the bank, which rises about twenty-two feet above the river. The bank is made up of about eleven feet of gravelly and stony drift clay, without any overlying lacustrine clay, underlain by a heavy bed of gravel and sand exposed along the bank a short distance above his house. Mr. Connelly also described his well as penetrating these materials only. In this gravel are pieces of Cretaceous lignite and slate. The presence of this gravel bed, and the rising and falling of the water of the well coincident with that of the river, proves a close relation between the two, but not a flow necessarily from the river to the well. There is not much doubt that the gravel bed is itself a vast water-reservoir, which is being filled by inflow from higher levels, and is slowly drained toward the river by hydrostatic pressure. The analysis of this water rather goes to show this to be the direction of flow, since there is much more mineral matter in the well than in the river water, a change that could not be produced by simply filtering through gravel for a few feet.

Descending the river below Connelly's, the light-colored, lacustrine clay, mentioned at Breckenridge, is seen to become more and more developed. and at last continuous, with a thickness of 25 or 30 feet, equal to the hight of the entire banks above the river, with only occasional exposures of the hard-pan clay near the river level. The hardpan finally disappears about two and one-half miles above McCauleyville, near "Aker's place," the last exposure being near the rope ferry. Below this place the lacustrine clay constitutes the entire bluff of the river. Before reaching this place the large boulders, which appeared frequently in the river for some miles below Breckenridge, had entirely disappeared. At the same time timber along the river becomes more and more abundant, and also larger. At first it consisted almost entirely of willows and box-elders, but as this change comes on large trees of white and burr-oak, ash, elm, bass and hackberry make their appearance. The bottom lands widen out, and at the same time become higher, reaching 15 feet above the water, while the lacustrine clay bank, outside of the bottom land, rises about 15 feet still higher. This lacustrine clay covers the country generally, east and west, especially up the tributary valleys; and it is plain to be seen that it will

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constitute a different agricultural land from the alkaline plain further south, based on the drift-clay.

There are here then these three formations, all pertaining to the drift:

1. Latest of all, *the alluvium* of the present river, which is mainly sandy, and supports the timber. It is without stratification generally, and swallows burrow in it. Its thickness varies with the hight of the freshet stage of the river, becoming greater toward the north.

2. The *lacustrine clay*, which covers the higher flats, and constitutes the soil of the valley over much of this region. It is of a light and loamy color, horizontally stratified, and is without stones or gravel. This is the sediment of the lake which was drained by the Minnesota river southward during the prevalence of the last ice-period, or on its partial withdrawal.

3. *The blue hardpan clay*—The immediate product of the great glacier, containing gravel stones and striated boulders. This fills the whole valley, running under the lacustrine clay and rising so as to constitute the surface of the country a few miles east or west of the river, becoming rolling, and even hilly, in the Leaf Hills and Coteau de Prairie, but lying smooth and level in the valley. This may have been originally deposited nearly level and smooth, as it now lies, owing to the presence and agency of much standing water, or it may have been somewhat smoothed off at a later date by the lake that covered it. This whole region, then, and especially the general aspect of the flats at Breckenridge, are a fac simile of the Maumee river and the "Black Swamp" region of northwestern Ohio, minus the timber and plus the alkali of the drift clay. Its origin was the same, and probably also its date, both pertaining to the period of the last glacial epoch. The theory advanced some years ago for the manner of deposit of this glacial drift*, here is confirmed by being equally applicable. It was received in these valleys, in a lake of water direct from the ice, and was let down gently without much modification, and stratification as fast as the ice sheet contracted; the horizontally laminated clay, in both places being the result of such lateral distribution of the clayey portions as the lake could effect, and of such later lacustrine deposit as water is apt to form, during its continuance as a lake. Further to

*Proceedings of the American Association for the Advancement of Science, 1872—*The Surface Geology of Northwestern Ohio*. Also the Popular Science Monthly for June and July, 1873—*The Drift Deposits of the Northwest*.

the north it covered the surface of the glacier, but by degrees became embraced further still north, in its general mass, and extended even to the bottom of the ice. It became superficial near the margin of the glacier by the thawing and wastage of the upper surface of the ice.

McCauleyville—James Nolan's well, 32 feet deep, affords a strongly alkaline water. It is situated on an irregularly ascending slope from the river toward the general level, and six feet below the general level. It was bored 17 inches in diameter.

Nolan's Well at McCauleyville.

1. Soil and black loam	2½ feet.
2. Brownish-yellow clay, with no noticeable stratification, nor gravel, nor stones	26 feet.
3. "Black sand," quicksand	4 feet.
4. Gravel, shells, and rounded stones, like the bottom of a lake, with water, went into it	1 foot.

This well seems to have got water in a layer of sand and gravel lying between the lacustrine clay and the hardpan clay, but on analysis it is proved to be heavily charged witn alkaline ingredients.

Langevin's Well at McCauleyville.

1. Loam and soil, and light clay	15 feet.
2. Blue, gravelly clay, with boulders, containing one layer of sand and gravel of 3 feet thickness, at the depth of 40 feet. No water of any amount was found in this well, and it was refilled. This blue clay had pieces of coal and Cretaceous slate, and granite boulders. The sand layer gave offensive water. At about 100 feet there was a layer of about 6 feet of very fine blue clay which makes a good polishing material	122 feet.

It is possible, if not probable, that in the foregoing the lacustrine clay assumed a blue color after passing 15 feet, and thus really extends to the layer of sand and gravel mentioned at the depth of about 40 feet, and which is said to have given offensive water. The absence of gravel and stones in the upper part of the "blue clay" was not, in that case, carefully noticed, and the color being the same would very naturally cause it to be set off with the great mass of stony blue clay lying below it. This hypothesis is all the more likely, as the offensive water from the sandy layer may then

be due to the vegetation and muck that would have accumulated in the bottom of the lake which immediately followed the deposition of the stony blue clay—a lake bottom which is also indicated by Mr. Nolan's well at about the same depth below the general level.

In digging Mr. David McCauley's cellar a large deposit of bivalve fresh-water shells was encountered. Other shells were found in digging the cellar of Mr. Longevin. These cellars are far above the river, and yet not so high as the general level of the country. These shells of course belong to the period of the lacustrine clay, either during or following the last glacial epoch.

There are said to be two terraces east of McCauleyville. One is four miles east, and consists of gravel, and one is thirteen miles east and consists of sand. There is a depression, or longitudinal basin, running north and south, between these terraces, in which water stands some years all summer.

At and below Fort Abercrombie are large and numerous selenite crystals. They were found by Mr. Nolan about three miles below the fort, in the slope of the bank of the river, and by the soldiers near the fort in digging a well. They are said to have occurred, in the well, above a heavy deposit of boulders: hence seem to be in the drift, and not in the Cretaceous.

Moorhead—In riding over the prairie from McCauleyville to Moorhead, a distance of about 30 miles, sometimes several miles east of the river, only seventeen granite boulders were seen on the surface. These were from six to twelve inches in diameter, and were entirely solitary, being generally half buried in the soil. There was seen no gravelly clay, nor small stones in clusters, nor any alkaline coating, all indicative of the drift clay, throughout the whole ride, but only a fine clay loam.

The well of C. P. Sloggy, at the Bramble House, is 22 feet deep, and wholly in the lacustrine clay, having struck at that depth a quicksand three or four feet thick, giving water. This well was recently dug (in May) and the water is tolerable, though evidently alkaline, and having a taste of the pine curbing. It is, however, less alkaline than water from the hardpan clay. It is said that there is a layer of sand all over this country, including Moorhead and Fargo, at about 22 feet, in which the same water can be got.

The well dug by Sharp and Douglas, situated in the public park, is across the street south from the last, and has the same depth. It now tastes (June 23, 1877,) as if kerosene had been poured into it. It

was dug about a year ago. The kerosense taste is owing to the decay and discharge of the pitch of the pine curbing, and will probably pass off.

Mr. Sloggy has another well dug to this layer of sand about a year ago, about two blocks further south, situated in the street, in an unfrequented part, which at first had a flow of good water, but finally became bad and had to be abandoned. On examination this was found to have the odor of decaying organic matter, and even of animal matter. It has been in disuse and shut for some months, the tight pine curb rising about 20 inches above the ground and covered with a board nailed over it. Hence the contamination cannot come from dead frogs nor rats, nor yet from sewage nor from surface indraining. Like most of the wells in the town the surface of the ground is elevated about the well, by throwing back round the curb the clay excavated in digging.

At John Erickson's Brewery is a well 105 feet deep, dug about two months ago (April or May, 1877). This well is used at the rate of 15 or 20 barrels per day. It is curbed with pine.

The Brewery Well at Moorhead.

1.	Light clay	20 feet.
2.	Quicksand	4 feet.
3.	Blue clay with gravel and boulders	80 feet.
4.	Sand, with copious water	

The water from the bottom of this well was under such hydrostatic pressure that it lifted up bodily "about two feet" of the entire clay bottom of the well, and rose immediately about 80 feet in the well. The water is strongly alkaline, but bright and clear, and is used for beer-making in preference to that of the river. This well was too recently dug, and is too copiously used, to show any markedly bad effect from the pine curbing.

The well of Lamb Bros. is sixteen feet deep, situated under the floor of a livery barn. It is curbed with pine. The water has an alkaline taste, which is said to be "sweet," and is very copiously used. It has never been noticed to be offensive, but will not do for washing. The clay here was but six feet thick, and the sand is said to have been ten.

Jacob Thomas' well is 14 feet deep, curbed with pine, smells and tastes of decaying organic matter, but not strongly of alkali.

Fargo—The well at the Fargo House is 25 feet deep, and the water is now good—as good as any water. It was dug one year ago, and is curbed with pine. Probably the fermentation took place last season. Indeed, a gentlemen who was at the house at Christmas affirms it was not so good then as now; yet the landlady, who probably would not notice a gradual change in the water, says it has always been as now; although she also admits it did "taste of the pine and was cleaned out." Another gentleman says it was not used for a time.

The well of J. C. Winslow is 25 feet deep, lately dug and just furnished with a pump. It is a good water also, as good as any hard water. The well is curbed with pine. For a time it was unfit for use.

At the Sherman House is a shallow well, dug four feet square, curbed with pine, has plenty of water which rises about ten feet, and is absolutely horrid with effete vegetable matter. It was dug last year, but has been in disuse for some time.

The well at the livery barn of A. H. Moore is a shallow well. It is curbed with oaken barrels and furnishes pretty good water, but has a pine pump running below the curbing. The water gives off a little sulphuretted hydrogen, but much less than the well at Mr. Moore's house.

The well at Mr. Moore's house is 96 feet deep, curbed with pine. It is an alkaline water, and has a strong odor of sulphuretted hydrogen.

Mr. McHench's well was dug for a cistern and is about 12 feet in depth. It is bricked up and cemented. The water broke in at the bottom and has always been good.

Mr. Roberts' well, near Fargo, is a shallow well, and smells very bad, but was very good at first. It has a pine curb.

A number of other wells were examined at Moorhead and Fargo, but the facts were only a repetition of the foregoing. They were all shallow wells, curbed with pine, had good water at first, and after a few weeks or months became foul and had to be abandoned.

The lacustrine clay is thinner on the Moorhead side than on the west side of the river, and wholly disappears a few miles east of Moorhead, the alkali of the hardpan clay appearing in low exsiccated spots. This occurrs before reaching the south branch of Buffalo river.

On visiting Moorhead again later in the season (September 1877) some of the wells that were unfit for use in June were found somewhat improved, especially those that had been copiously pumped. The Bramble House well was not improved, but rather had become worse. Mr. Sloggy referred to the well of Mr. Mangus Peterson as a curious illustration of the fickleness of the water in the Moorhead wells. This is situated only across the street from his at his house, dug about the same depth (26 or 27 feet) and is curbed like his with pine, but affords the "best water in the town." This seemed to imply that the fault is not in the curbing. On examination of this well it was found, as stated, to afford as good water as Mr. McHench's in Fargo, and was dug in September, 1876. It had been so foul that it was not used for several months. This summer it was emptied repeatedly and began to improve. The neighbors also began to use it, so that it soon acquired a reputation for its excellence. In this case the copious use of the well is what renders the organic impurities imperceptible. By standing it will probably relapse into as bad a condition as before.

Glyndon—At Glyndon the wells are all alkaline, and also generally about sixteen or twenty feet deep. They pass at once into the hardpan clay. They are all curbed with pine. Only one is now fit for use. It is that of the house lately purchased of Major Tenny by James McLenan for use as a hotel. This does not taste of organic decay, but is strongly alkaline. The well at the present McLenan House is very foul, but the former is freely used by the whole village. The well at the Campbell House is not used. It is very heavily charged with organic decay in its foulest stage, and has been in disuse much of the time for four years. Though cleaned out about a year ago, and used slightly for a few months, it is still unfit for use. It is within a few rods of the above named well which is used by most of the families of the village, and has about the same depth. Water from the well in general use was examined chemically by Prof. Peckham, and compared with a similar examination of that from the Campbell House, without showing any important difference in the impurities contained in solution. They are both hard waters. While from one is escaping constantly a volume of noxious organic odors, including sulphuretted hydrogen gas, the other is wholly inodorous, and is freely used for all domestic purposes. It is plain that there is something in the surroundings of the wells which causes the difference. They are both curbed with pine and were dug some years ago. It is also probable that the

copious use of the one keeps it substantially inocuous, while the disuse of the other intensifies the foul qualities. That in constant use is a large open well. That which is foul may be confined and covered. It is also evident that the bad qualities of these wells cannot be detected by the ordinary chemical examination of their mineral impurities. In other words, the foul odors arise from organic ingredients which are volatile. There is no other supposable cause for these odors adequate to the explanation of so prevalent a disorder, than to attribute them to the decaying pine curbing which is co-extensive with the disorder.

There are several other wells at Glyndon, but they are all bad from the same cause. They are sunk in gravelly clay, and get water in gravel.

The well at the Round House, situated somewhat west of the village, was dug in 1872 by the St. Paul & Pacific Railroad, and is reported as follows by Chas. A. F. Morris, who was Chief Engineer when the well was dug:

Round House Well at Glyndon.

1. Black soil	1 ft. 3 in.
2. Yellow quicksand	12 ft.
3. Blue quicksand, sheets of turf and vegetable deposits	3 ft. 6 in.
4. Blue clay and drift wood	2 ft.
5. Blue clay	2 ft. 7 in.
Total depth	21 ft. 6 in.

This section is interesting, as it reveals a layer of drift wood 18 feet below the surface. While this was probably deposited by the current of Buffalo river, which runs near Glyndon, during some earlier history of its channel, which then must have occupied a different position from what it does now, it may still be due to water-logged drift wood that was gathered along the shore of the ancient lake that once extended to or even beyond Glyndon. The character of the material overlying the drift wood ("yellow quicksand") strongly indicates the fluvial rather than the lacustrine origin of the drift wood. Its not having been discovered at other points is cumulative evidence of its not extending generally under the country about Glyndon, as it would be more likely to do if of lacustrine origin. Hence it is not likely that the bad odors of the wells there are attributable to vegetable decay from that source. If it were demonstrated or admitted that vegetable decay is the cause of

these odors, it would be folly to overlook the chief known source of such contamination (the pine curbing) and search for it in the soil or clay, or buried drift wood.

At Fisher's Landing, just below Crookston, on Red Lake river, the grade of the railroad is made of gravel, rounded by water action, similar to that seen in a number of places along the road between Glyndon and Crookston, where wave-action has carried away the clay from the drift, and has left the gravel stones strewn over considerable areas. A double handfull of these pebbles, from one-half to one inch in diameter, picked up without selection, afforded seventeen of fine, compact limestone, and four of metamorphic rock. This shows probably an average proportion of limestone pebbles to metamorphic in the drift of the Red River valley in general; though it is probable the limestone pieces would be more numerous still further north, and less abundant toward the south. These limestone pieces are strewn with the drift all over the western portion of the State, even to the Iowa state line, large pieces sometimes being found in the southern tier of counties. They come from the Winnipeg limestone.

Winnipeg—By the courtesy of the officers of the Red River Transportation Company the party were taken to Winnipeg and there made further examinations.

Connell and Burke's well, dug about a month, is 56 feet deep. The water was at first good, but now has a faint taste of sulphuretted hydrogen. This may be attributed to the wood curbing placed in the well, which is of spruce. The well went through 40 feet of fine brick clay, and 16 feet of stony clay, with boulders of granite and limestone.

Wm. Hespeler's well on a lower terrace level, dug three years ago, was used last year by two water-carts in distributing water throughout the city, and was good, but now it is little used, and has a sulphuretted taste. It passed twelve feet through brick-clay and obtained water in quicksand; has pine curbing.

Wm. Hespeler's old well, on the same level, dug four years ago near the last, formerly had a sulphur taste, but now furnishes a beautiful cold water. It is also twelve feet deep. It has a pine curbing.

Thos. Maxwell's well is near the last two; was dug this spring, and furnishes perfectly good water. It is the same as the last two in all essential particulars, except that it is copiously used by three water carts in delivering water in the city. Its depth is also a lit-

tle greater, but the water is from quicksand. The overlying clay was found to be, as in those, about 12 feet. No stony clay was met with in these wells.

The Messrs. Chambers Brothers have just completed a well, and put in wooden curbing. It is on the upper flat and 57 feet deep, much of the depth being in a stony clay. The water is alkaline, and as yet has no taste of sulphuretted hydrogen, or organic odors.

The well at the Union Hotel is "sweetly alkaline." It is just dug, has a wooden curbing, and is 57 feet deep; in gravelly clay.

The well at the Free Press building was dug four years ago, and is 59 feet deep. The water is alkaline and sulphuretted. The well is curbed with pine, which still affects the water. The water rises from a gravelly clay deposit near the bottom, and stands within ten or twelve feet of the surface. It is not much used.

[NOTE—The first well of Mr. Hespeler, mentioned above, is at the Orilla House. It is near a barn, with a manure pile very near. It was foul, and on being cleaned two or three dead gophers were taken from it. His second well is at his brick block, but not more than forty feet from the first. It was also foul and "stagnant" last year, but on being more pumped became good again. The Maxwell well is between them and in a low barnyard or muddy spot. It is used by three water carts. The tight clay of which the surface consists seems to shed all surface impurities whenever the slope is away from the well. This is shown by the Maxwell well which, though favorably situated for surface indrainage, is perfectly free from these bad odors, and is largely used.]

The lime rock at Andrew's Rapids, twelve miles below the city of Winnipeg, is quarried and used for all building, and even as dressed cut-stone for large ornamental fronts. That at Rocky Hill, or Stony Mountain, where the penitentiary is built, 17 miles northwest of the city, seems to be of the same general age and texture, but is more fossiliferous and irregular. Its color is a light buff, or faded drab. It is in all respects, exactly like the boulders and gravel strewn so abundantly over western Minnesota.

At this place the lacustrine clay makes a cream-colored brick. Below it, or in it, is a sand layer, which does not seem to be everywhere met, which gives good water not perceptibly alkaline. The drift-clay below gives a strongly alkaline water. There are some artesian wells in this neighborhood which rise from below the blue drift-clay, or hardpan.

White Earth.—Mr. G. A. Morrison, of the White Earth Indian Reservation is authority for the statement that the same difficulty with bad water is encountered there. The wells are dug in the drift

clay, and are all curbed with pine, with one exception. That also was at first, but the curb was taken out and stone walling was put in. The water was bad before the change, but now it is good.

Detroit.—Wells at Detroit enter gravel within twenty-five or thirty feet, and find a good lining and chalybeate water in abundance. Wells are curbed with pine. The country here is rolling, and the drift clay is very gravelly; indeed the gravel which furnishes the water of wells seems to rise to the very surface. No trouble with foul water.

Perham.—Here the soil is a loam, and the subsoil and drift are gravelly, allowing free underground drainage. Water is found at 20 and 30 feet. Some pine curbs have been used, but there has been no trouble with foul water. The supply is copious.

Brainerd.—Many of the wells curbed with pine at this place are foul in the same manner as at Fargo, Breckenridge, &c. Attention was directed to the fact by Dr. J. C. Rosser, of Brainerd, in connection with the occurrence of numerous cases of typhoid fever which had been attributed to the use of bad well-water. The soil here is sandy, with some clay, with a clayey sub-soil. In company with Dr. Rosser and Dr. V. C. Smith, of Duluth, the writer visited and examined about twenty wells. They were found to be all curbed or walled with pine. They have an average depth of thirty-five to forty feet and penetrate a stony clay deposit. They have mostly been dug for a number of years. The majority have a distinct taste of decayed wood, and are turbid with floating particles from the pine. The smell is not so rank as in many in the Red River Valley, and in most of them no offensive odor can be distinguished, though to the taste there is a distinct trace of organic decomposition. They seem to have a great deal of detached floating (or suspended) fungus growth, which is of a yellowish-brown color and inodorous. These wells are in what might be styled the second stage, or one of fungus growth and dead wood, which is a natural sequence of the rank and odorous stage which they first pass through. The occurrence of frequent cases of typhoid fever both at this place and in the Red River Valley, taken in connection with bad well-water in both places, was suggestive of the possible existence of a common cause. It was for this reason that Dr. Rosser desired an examination of the Brainerd wells. Three samples were procured for chemical examination. They were examined by Prof. Peckham with the following results:

Analysis of Well Waters from Brainerd.

Owner's Name.	Serial Number.	Total Solid Residue.	Mineral Residue.	Organic and Volatile Residue.	Permanent Hardness.	Removable Hardness.	Total Hardness.	Chlorine.	Free Ammonia—Pts in 100,000,000.	Albuminoid Ammonia—Pts in 100,000,000.	REMARKS.
C. H. Alsop...	49	32.287	24.283	7.004	8.172	6.44	14.593	42.728	132.	49.	Sulphuric and Carbonic acids, a trace.
Al. White.....	50	16.519	13.250	3.269	6.129	3.210	9.339	4.027	0.	0.	" "
Leland House.	51	37.241	30.937	6.304	9.923	4.378	14.301	50.900	26.	13.	" "

No. 49, above, was from a well used by a family in which there had been a recent case of typhoid fever. The water had been condemned some time before, and the well cleaned with the discovery of several dead mice; but since the cleaning the water had not been noticed to be bad again. The fever occurred after the use of the well subsequent to its being cleaned. At the time the sample was taken the well had been standing again unused, from the removal of the family, for a few weeks. It has a pine curbing. On visiting this well it was found to be perceptibly contaminated with organic decay, which was perceivable by the smell as well as by the taste.

No. 50 was from a well that was not known to have any bad taste or to have been accompanied, in its use, by any cases of fever, though curbed with pine.

No. 51, at the Leland House, there had been several cases of typhoid fever during the summer. Indeed, with the single exception of the case in the family of Mr. Alsop, all the cases in the town, (season of 1877) were confined to this house. The water from this well, which is in the kitchen and not well protected from surface indrainage, has a distinct odor and taste very much the same as those in the Red river valley, though less rank. This well is curbed with pine.

These analyses give abundant evidence of organic matters in these wells. The albuminoid and free ammonia can have no other plausible explanation ; but although at the present time their use is visited with typhoid fever, they are no worse than many others which were examined, and probably no worse than most of the wells of the place that are so curbed, during some former portion of their history. In former years this town has been severely afflicted with typhoid fever. At one house, formerly use as a hotel, it had been so common that the house was for some months a very

hospital of typhoid fever, but now is not so much troubled. This well, however, is still bad from the same cause, but has passed its foulest stage. In other cases when these wells have been unused for some time, the odor becomes intensified; and it is a singular fact that familiarity with and use of the water renders it impossible to distinguish it, and even makes it agreeable. The most of the wells examined were said to have "good water" by the owners. Occasionally a man is found who says his well "tastes of the wood;" and also one occasionally who really knows that the water becomes foul from the pine, and recommends instead that *oak* be used.

In Mr. Follet's well, near Mr. Alsop's, the decay is just begun, the well having been dug this summer. It shows in iridescent films that float on the surface of a cupful, but does not now taste very bad.

Herman.—The deep well at this place was drilled by C. E. Whelpley, of Minneapolis, and the following record of it was furnished by him:

1. Blue clay	124 feet.
2. Rock	65 feet.
Whole depth	189 feet.

Water from the top of the rock rose to within six feet of the surface. There was considerable coal on the surface of the rock. The rock was very hard to drill and showed several changes within the sixty-five feet. The following letter may here be given pertaining to this well.

MINNEAPOLIS, MINN., 23d March, 1878.

C. E. Whelply, 1506 3½ Street South:

DEAR SIR:—I have just received your letter of March 22d, written at Herman, containing samples of rock taken from near the bottom of the well you are drilling there; in which you ask me what kinds of rock they are, and the probability of getting a flowing well by drilling deeper. The samples are as follows, as you numbered them, in descending order.

No. 1. "Found 124 feet under blue clay, seven or eight feet thick." This is the same stone as the limestone boulders that lie strewn over the surface of the Red River flats from Winnipeg to Big Stone Lake and beyond, and is found outcropping at the surface beyond the limits of Minnesota in Manitoba. It is a fine grained, buff, magnesian limestone, of the Silurian or Devonian age. Your let-

ter seems to convey the idea that this lies in a layer seven or eight feet thick immediately over the rock of the next number. That would be anomalous and unexpected. It is very probable that this fragment is from a drift boulder, and that the thickness of seven or eight feet was occupied with a compacted boulder-mass, mostly made up of such rock. It is true that nearly all the boulders and gravel of the drift in that whole region are of this rock, and, according to a well known fact, boulders are much more frequent in the lowest ten feet of the drift than in any other part. * * * * * * * *

No. 2. This is a quartzose, granite, parti-colored by flesh-red feldspar. It is but a small piece, but is compact and fresh. It has but little mica.

No. 3. This is a white, micaceous quartzyte, in which there seems to be a little gray labradorite.

No. 4. This is a fragment of crystalline feldspar, with one rectangular cleavage, and a dull, vitreous luster,—an orthoclase.

No. 5. This fragment consists of glassy quartz and mica.

No. 6. Mica schist, with associated talcose rock.

No. 7. Mica schist with veinings of calcite.

No. 8. Mica schist, changed in color by heat applied since it was taken out of the well. (Same as No. 6.)

No. 9. Coarse mica schist. This came from a depth of 186 feet, and is said to have begun at 180 feet.

A glance at these samples is sufficient to show that your well is now in the metamorphic rock, the strata of which are discordant and highly tilted, and from which there are no instances of artesian overflows that I have ever heard of. All our artesian wells are in higher geological horizons. I should unhesitatingly discourage you from drilling any deeper in hope of getting a flowing well. These rocks are several thousand feet in thickness, and are followed by granites and syenites, in which there is no better chance of artesian water.

Very respectfully,

N. H. WINCHELL.

The Surface Geology of the Country.

It is not possible to give a full account of the surface deposits of the valley of the Red River of the North. This sketch will be confined to such general views as may be gathered from a hasty reconnoisance, based on such facts as an inspection of the banks of the river at numerous points and the examination of the foregoing wells have afforded. The full details will have to be filled in by subsequent and more elaborate exploration.

It is found that the lowest portion of the drift consists of a stony clay, which below contains more abundant gravel, and throughout many stones and boulders. It is also probable that many wells which have been supposed to have passed through it, have only struck water-bearing courses of gravel or sand in the clay itself. This deposit is generally blue. When it is at the surface it is

lighter colored. The stones which it contains are from various formations, but about 75 per cent. of them seem to belong to the Winnepeg limestones. The rest of the stones are granitic. This clay also contains Cretaceous debris, such as slate and lignite. Such lignite sometimes is rather plentiful, and indicates that the Cretaceous formation, which is rather fragile and incapable of enduring long transportation, underlies large portions of the valley, if not the whole of it, and that the clayey portions of the stony clay have been very largely derived from the disintegration of this formation. This is further evinced by the occurrence of crystals of selenite in the drift deposits near Fort Abercrombie, the sulphate of lime being one of the alkaline salts that seems to have been abundantly in solution in the waters of the Cretaceous ocean. This vast clayey deposit of unmodified drift rises to the surface round the margins of the valley and spreads out in extensive flats, on both sides of the river, and between Breckenridge and Big Stone Lake toward the south. This flat surface passes by insensible degrees to one more rolling, and at the same time becomes more stony, toward the east, making the bulk of the Leaf Hills in Minnesota, and toward the west making the Coteau de Prairie in Dakota. It is essentially and typically a glacier-deposit, its varied aspects being due to the agency of water, present at the time of deposition, and either running with considerable current so as to wash out the clay and make stratified gravels and sands within the mass, as in the Leaf Hills and in the Coteau, or in the form of standing water, by which the clayey parts were retained and the whole spread out with a smooth upper surface, without much modification of structure.

After this drift clay was deposited there was for a long time a large lake of fresh water standing over the valley of the Red River of the North, which had an outlet toward the south by way of the Minnesota valley. This lake probably began its existence during the last period of ice, and was caused, at least during the latter part of its prevalence, by the glacier ice itself, which obstructed the northward flow which the natural slope of the country indicated and required. This lake began its existence on a much more restricted scale near Big Stone Lake, and it received and spread out evenly, as already noted, the glacier drift as fast as the glacier brought it forward. It grew toward the north as fast as the retreating ice sheet made way for it. At length, when there were partial or periodical openings in the northward outlet by way of Winnipeg, its shore line advanced or receded as the outlet opened or closed by the seasons of the waning glacial winter. Hence the

fine deposits which it spread widely during the times of its highest stages were withdrawn by the receding beach line during the times of its shrinkage and partial discharge northward. Hence the lacustrine clay is not spread so widely as would be expected from the existence of beach marks at some elevated levels.

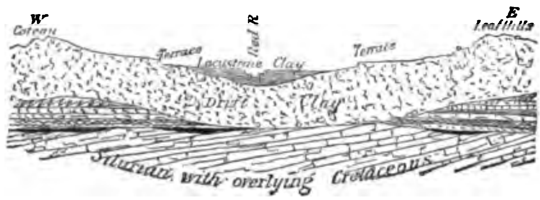
It was the water of this lake during its period of agitation and instability that produced the next noteworthy member of the drift deposits in the Red River valley. This is a layer of gravel and sand, sometimes containing fresh water shells in abundance, as at McCauleyville, which nearly everywhere underlies the lacustrine clay and affords water. This sometimes is several feet thick. It lies directly on the upper surface of the boulder clay, but it does not extend generally over that surface where the lacustrine clay is wanting.

The lacustrine clay is horizontally stratified, and contains no stones (at least none have been seen) nor gravel. It is fine and close. It is of a yellowish or earthy color; or at considerable depth it may be bluish. It makes cream-colored brick. It contains less of the "alkali" than the drift clay Its area is about twenty-five miles wide in Minnesota, but it extends westward into Dakota with about equal width, or perhaps greater, and runs northward into Manitoba with an increasing width and thickness. It is barely found south of Breckenridge. Its special location is along the river, covering a belt on either side, and widening east and west up the tributary valleys. But the most of the surface of the Red River valley, within Minnesota, seems to be formed of the drift clay, showing stones and gravel in abundance. There is not much doubt that this lacustrine clay was once spread more widely over the surface of the drift clay, and was removed by the action of the slowly retreating shore line.

The latest of the surface deposits is the alluvium of the river, which sometimes becomes a very important one. Its amount and area are greater further north. While this is generally an incoherent, amorphous and arenaceous deposit rich in vegetable humus, and is confined to the immediate valley between the bluffs formed of the older foregoing clays, yet there are some places where it is more compact, and has an undulating stratification that somewhat resembles that of the lacustrine clay into which it then seems to pass. Such cases are not common, however. It is this deposit that bears the timber that occupies the valley. It is much more abundant where the lacustrine clay forms the river banks than where they are composed of drift clay.

The adjoining diagram, representing a transverse section of the valley at Moorhead, illustrates the superposition of these parts of the drift.

FIG. 1.



Section across the Red River Valley at Moorhead.

The Chemical Peculiarities of the Waters of the Valley.

In general the waters of the entire valley are alkaline*, whether taken from wells, springs or running streams. That is to say, they contain considerable amounts of lime, magnesia and soda, combined as sulphates, carbonates and chlorides. They are not often very bitter, indicating a moderate amount only of the chlorides of calcium and magnesium, but they contain on the other hand not a sufficient quantity of sodium chloride to allow of denominating them saline. The soda is probably in the form of bicarbonate, with a small proportion ot chloride, the lime as carbonate and sulphate, and the magnesia as sulphate. Indeed the most predominant taste is that of sulphate of magnesia, or epsom salt. The waters of the valley are not equally affected by these mineral ingredients. Those

*The analysis of the "alkali" of the western prairies, taken from the south bend of Moose river, in Dakota territory, by Prof. E. H. Twining, is given in the report of the Superintendent of Public Instruction of the State for 1870. [Ex. Docs. of 1871.]

1. Coarse gravel, principally quartz	28 per cent.
2. Finer material, principally quartz sand	18 per cent.
3. Fine dust, (passes through a sieve of 80 to an inch	54 per cent.
Total	100 per cent.

COMPOSITION OF NO. 3.

Loss by ignition (water and organic matter)	3.99 per cent.
Insoluble in acids (principally quartz sand)	67.47 per cent.
Soluble silica	1.36 per cent.
Sulphuric acid	7.43 per cent.
Carbonic acid	5.98 per cent.
Lime } Combined with Carbonic Acid	3.62 per cent.
Magnesia } Combined with Carbonic Acid	1.18 per cent.
Potash	1.05 per cent.
Soda	6.18 per cent.
Alumina and Sesquioxide of irom	1.72 per cent.
Chlorine	Trace.
Total	99.98 per cent,

springs or wells that obtain their water from the drift clay are the most uniformly and strongly affected. Those whose source is in the lacustrine clay, or from the sandy layer between it and the drift clay, are much less alkaline, as a general rule, though it is not at all impossible that that layer should contain water derived immediately from the underlying drift clay, which would be as strongly alkaline as any directly from the drift clay. The waters freest from these mineral impurities are those found in the streams. Of these streams those will be found least alkaline that flow wholly or mostly over the lacustrine clay, and hence they are in the northern portion of the valley, where the lacustrine clay spreads wider. The water of the Bois des Sioux is purer (so far as these ingredients are concerned) than that of the Otter Tail. The former is the outlet of Lake Travers, and it is confined wholly to the immediate river valley, having only inconsiderable streams flowing from the drift clay surface. The Otter Tail, on the other hand, rises in the Leaf Hills, and flows for several miles, and nearly its whole course, over the alkaline drift clay.

These alkaline qualities are remarkably affected by organic impurities. In some of the natural waters of the valley this effect is noticeable, particularly in those which are sluggish. Some low grounds, in which vegetation grows rankly some portions of the season, but in which these alkaline waters collect and stand for some weeks or months during the early part of the following season, are offensive with sulphuretted hydrogen, while the waters themselves are foul and sickening. Such effects are due to the reaction of the decaying vegetable growths on the alkaline salts of the water, which converts the sulphates into sulphurets, which in turn are changed by the carbonic acid present, with the separation of free sulphuretted hydrogen, and the formation of carbonates. The small streams of the valley are also apt to be nearly stagnant during the summer season while they choke up with grass and other vegetation, and become heavily charged with organic matters. These react on the sulphates and materially affect the mineral condition of the waters, and their usefulness for domestic or agricultural purposes, They generally continue to be used for watering places for stock, and are sometimes hauled in barrels for household purposes. If these reactions are perfectly balanced by even portions of organic matters and alkaline minerals the soluble sulphates in the water may be wholly converted into insoluble carbonates, thus mainly freeing the water both of organic acids and of the usual mineral ingredients. But this is usually not the case. In the spring months, and during wet seasons, the alkaline ingredients

overbalance the organic acids; but during the summer and fall, when the springs run low, and the developement of organic substances, and their decay, are most active, the organic impurities are in excess of the alkaline, and the waters show their worst condition —which is prolonged by the flatness of the surface, and the consequent slowness of natural drainage.

The waters of the valley generally do not have an offensive odor. It is only in stagnant and confined water these effects are noticeable. The chemical interaction is so slow that the resulting gas escapes unobserved, and the waters are slowly purified by the change. Suspended organic matter is also rapidly oxydized by contact with the atmosphere.

The following report of Prof. Peckham to Dr. C. N. Hewitt, shows more fully the chemical peculiarities of the waters of the valley from different localities :

Dr. C. N. Hewitt:

MY DEAR SIR—I have the pleasure of submitting the following report of the examination that I have just concluded of the specimens of water collected on our trip through the Red River Valley. They were gathered from the following named localities:

No. 1. The flowing well at Tintah, St. P. & P. R. R.
No. 2. St. Gabrielle Springs, near Campbell, St. P. & P. R. R.
No. 3. Well at Campbell Station, St. P. &. P. R. R.
No. 4. Otter Tail River, at Breckenridge, St. P. & P. R. R.
No. 5. Bois des Sioux, at Breckenridge, St. P. & P. R. R.
No. 6. Well at Connelley's, on river, four miles northwest of Breckenridge.
No. 7. Wild Rice River, west of Fort Abercrombie.
No. 8. Well at Nolan's Hotel, McCauleyville.
No. 9. Well at Brewery, Moorhead (Artesian).
No. 10. Well at Bramble House, Moorhead (surface).
No. 11. Well at Glyndon, good—in general use.
No. 12. Well at Glyndon, bad, McLenan's.
No. 13. Town Well at Breckenridge.

They were selected for the following reasons:

No. 1 was from a well that was dug only a few feet into the level prairie, which furnishes a stream of water constantly flowing over its brink. The water of this well is considered of fair quality, and is used at several of the stations on the St. P. & P. R. R. in that vicinity. It was therefore thought best to examine it.

No. 2 is from St. Gabrielle Springs about 2½ miles from Campbell Station on the St. P. & P. R. R., situated on the banks of a small stream called Rabbit River. These springs are the only natural outlet for water in that part of the country so far as could be learned.

No. 3 from the well at Campbell Station was represented as being very bad, and quite unlike either Nos. 1 or 2. As this well was quite deep and in the immediate neighborhood of 1 and 2 it was thought desirable to know in what respects they differed.

No. 4 is considered by the inhabitants to be the best water in the upper Red River Valley, and with No. 5 is extensively used along the banks of the two rivers. As these two waters in mingling form the Red River, it was thought desirable to ascertain their quality and their differences, if such existed.

No. 6 was selected because there was reason to believe that it was the river water filtered through beds of gravel which formed the river bottom at that point. It was thought desirable to know if such filtration removed mineral matter from the water.

No. 7, from a tributary of the Red River has a bad reputation. It was thought advisable to compare this water with that of the Otter Tail.

No. 8 appeared to be bad from excess of mineral matter, and at the same time it was different from the well at Breckenridge. For that reason it was thought best to examine it.

No. 9 was selected as representing the water of a very deep well, and No. 10 as representing the water of a shallow well from the same locality, that had been recently dug. It was thought best to compare them.

Nos. 11 and 12 were from two wells very near together and very unlike, one being considered very good and the other very poor. It was thought best to compare these and ascertain if possible why the water in the bad well should have become sulphurous.

No. 13 was the town well at Breckenridge. When selected it was supposed to represent the bad well water of that locality. It was probably much worse than the average.

The accompanying table gives the results of the examination of these specimens. In estimating the total mineral and organic constituents, 100 c. c. were evaporated over a water bath and when dry the residue was heated to 130 deg. C. in an air bath. It was then cooled and weighed, and the amount calculated as "total solid residue." This residue was then heated over a Bunsen's lamp and the organic matter burned off. The residue remaining was calculated as the mineral matter in solution and the difference as volatile and organic matter. This difference can not be safely computed as organic matter excepting in those cases when the mineral ingredients existed chiefly in the form of bi-carbonates. Sulphates in some instances and chlorides in nearly all, retain water at 130 deg. C. and when the amount of such salts is comparatively large, they prevent the complete combustion of the organic matter by fusing and enclosing particles of carbon. No. 13 may be noticed as an example of this difficulty. The organic and volatile matter estimated from difference is 91.412 of which only 22.298 grains is actually organic matter.

The soap test was then employed to determine the total hardness, permanent hardness, and by difference, the removable hardness. Also the sulphuric acid, lime and magnesium. This test gave satisfactory results on all of the specimens but one. In No. 11 the permanent hardness was greater than the total hardness; that is, the water was harder after boiling than it was before. The tests were repeated until no doubt could be entertained of the fact. I cannot explain this anomalous result. For SO_3 the soap test appears to give very satisfactory results, but for lime and magnesia the process as described are highly empirical and give results of but little or no value except when applied to water containing

those bases as carbonates, and which at the same time is free from alkaline sulphates and chlorides. Waters containing the last named salts are rendered harder by them. If then the total hardness is used as a basis for the estimation of the lime, it is obvious on a moment's reflection, that if, as advised by Parke, the total hardness in tenths of a cubic centimeter be divided by four and a drop of ammonium oxalate solution added for every four degrees of hardness in a carbonated water, the same rule applied to a water containing alkaline chlorides or sulphates would cause an addition of anexcess of the precipitant which adds to the hardness. For this reason I found it impossible to estimate the lime by the soap solution in Nos. 7, 9, 11 and 12. I have but little confidence in the results given for the other numbers. The magnesia was still worse for the entire hardness produced by alkaline chlorides or sulphates is included in the magnesia by Parke's method, as neither chlorine or sulphuric acid in combination with the alkalies is precipitated either by boiling or by ammonium oxalate. I have therefore omitted the estimates of magnesia in all cases as in those in which the determination was made. I had no reason to believe the figures reliable. The chlorine was estimated by a standard solution of silver nitrate, verified in No. 13 by precipitation and weighing; in which case the results corresponded to one one-hundredth of a grain.

We have reliable data therefore for comparing the waters in reference to the amount of mineral matter in solution, the total and permanent hardness, the sulphuric acid and the chlorine.

A comparison of the different specimens shows a range of amounts of mineral matter in solution varying from 6.304 grains to 390.158 grains in a gallon.

Numbers 13 and 8 are properly termed mineral waters. Numbers 1, 2, 3, 10, 11 and 12 are very hard well and spring waters; numbers 6, 7, and 9 are ordinary hard waters, while numbers 4 and 5 are quite pure river waters when we consider that they flow from and over sedimentary formations.

Numbers 4 and 5 are quite free from sulphates and chlorides. It will be further observed in reference to the remainder that with the exception of number 13 the sulphates are not extremely large, while again excepting number 13 the chlorides are very large, especially in numbers 7, 8, 10, 11 and 12. These results are unexpected, and I am especially surprised to obtain unmistakable evidence that the water of the Bois des Sioux river is purer than that of the Otter Tail—in fact is the purest water in the valley. A remarkable difference is also observed between the water of these rivers and that of the well at Conelley's. The mineral matter has increased about four fold, the chlorine seven fold, and the sulphuric acid three fold. These facts imply that the well water cannot be simply the river water, filtered through the gravel of the river bank.

So far as these results bear upon the subject of our inquiry they show that the waters of the Red River Valley do not contain large amounts of sulphuric acid, but that they are heavily charged with chlorides, probably largely combined with lime and magnesia. As a consequence they produce very hygroscopic residues when evaporated, and the accurate determination of the total solid residue or mineral constituents becomes extremely difficult if not impossible. An examination of the table shows that in every specimen in which the chlorine is large the organic and volatile matter is also large. This is not on account of an excess of organic matter but because the latter item is estimated by loss, and the loss consists of water retained at 130 deg. C., and also of a part of the chlorine from the decomposed magnesium chloride.

I cannot venture an opinion based upon these results, as to the cause of the water of many wells becoming fœtid on standing, or when the well is used but little or not at all. Number 11, is a colorless, odorless water, used by the entire population of Glyndon. Number 12. is from a well but a few rods distant from No. 11. It is of a yellowish color, contains a black sediment, and is heavily charged with sulphuretted hydrogen gas. Examination has thus far proved them to be of the same general character, with no difference in any respect that can be regarded as important. If the solution of this question is deemed desirable, I should recommend the selection of a number of typical specimens and their complete analysis, for organic, as well as mineral constituents. I should also advise a microscopic examination by an expert if possible. I would recommend as preliminary to the selection of these specimens, a further exploration of the valley, and an examination by the soap test, and for chlorine, of a large number of waters, particularly those from springs, and if possible from wells that are free from exposure to filtration of surface drainage, and filth filtered from sink drains, barn yards, and the streets of towns.

As an illustration of the difficulties attending the drawing of any conclusions from the results thus far obtained, Number 9 may be mentioned. The permanent hardness is less than in any other specimen, indicating an absence of magnesium, sulphate and chloride. There was no calcium and magnesium chloride in the residue. Therefore, no water was retained at 130 deg. C. The 9.147 grains of organic and volatile matter is doubtless organic matter, and is a comparatively large quantity. The source of this organic matter it is impossible to determine, unless its character be ascertained. The water smelled as if contaminated with sewage from a sink, and may contain the soakage from the Brewery in which it is situated, or the organic matter may be derived from the clay. The bad well at Glyndon is near a barn, and the surface around it was covered with kitchen slops when the specimen was obtained. The residue from the water had a decided odor of urine. The question whether these organic contaminations are derived from the subsoil or from surface infiltration, becomes therefore a fundamental consideration, with reference to the prevention of cure of the undoubted bad qualities of most of the water examined. The amount of calcium bi-carbonate is not large in these specimens of water, while chlorides are abundant. It would not therefore be advisable to recommend the use of Clark's lime process.

An examination showed the clay to contain a large amount of organic matter. No other result could have been expected. Respectfully submitted,

S. F. PECKHAM,
State Chemist.

Number.	Total Mineral Matter.	Organic and Volatile.	Total Residue at 130° C.	Removable Hardness.	Permanent Hardness.	Total Hardness.	Chlorine.	Sulphuric Acid (SO_3).	Lime (CaO.)	REMARKS.
1	53.119	5.078	58.197	2.061	8.026	10.507	13.075	2.568	2.098	Colorless, odorless, had deposited iron.
2	62.458	12.316	74.764	10.216	15.468	25.684	10.623	4.202	7.647	" " " "
3	55.454	12.841	68.295	8.756	11.960	20.722	No estimate.	5.370	6.864	Turbid, odor of putrid brine ; iron.
4	8.279	4.142	12.421	.584	5.545	6.129	1.400	1.467	2.000	Colorless, odorless, had deposited iron.
5	6.304	5.137	11.441	3.210	4.086	7 296	1.400	.700	2.654	Yellowish, odorless.
6	26.617	3.210	29.827	3.210	7.880	11.090	10.098	3.502	2.980	Colorless, odorless.
7	33.156	11.440	44.596	0.000	8.436	8.436	28.077	0.000	No estimate.	Odor and taste swampy, yellowish.
8	196.656	34.556	231.212	43.779	20.430	64.209	42.728	(?)	6.864	Musty, dirty yellow, much iron.
9	31.988	9.147	41.135	12.550	1.167	13.717	9 740	2.334	No estimate.	Colorless, odor like a sink drain, deposit like clay,
10	48.967	43.662	93.629	9.340	6.712	16.052	156.204	2.334	2.918	Colorless, odor marshy, deposit like clay.
11	41.736	17.628	59.364	(?)	20.038	13.133	46.289	1.467	No estimate.	Colorless, odorless, deposit of iron.
12	49.675	20.488	70.163	3.502	5.837	9.339	56.096	2.200	No estimate.	Yellow, odor of H_2S, deposit black.
13	390.158	90.412	481.570	No estimate.	No estimate.	No estimate.	1.061	174.241	45.658	Residue on evaporation had the appearance and odor of a urine residue.

	Total Mineral Matter.	Water, etc. retained at 130° C.	Organic Matter.	Total Residue at 130° C.	Residue in $BaSO_4$.	Insoluble, HCl SiO_2.	Fe^2O^3 and Al_2O_3.	SO_3.	Cl.	Fe_2O_3, Al_2O_3 and $Fe_2P_2O_8$.	CaO.	MgO.
13	390.158	69.114	22.298	481.570	51.542	4.412	3.035	174.241	1.061	10.723	45.658	29.443

Conclusions.

The foregoing ascertained facts will warrant the statement of sundry conclusions which may be given briefly as follows: They pertain to the solution of the question—whence come the foul odors of the wells in the Red River region?

1. The drift clay affords a strongly alkaline water.
2. The lacustrine clay affords a slightly or non-alkaline water.
3. There is generally a water-bearing stratum of sand, or of gravel and sand, between the lacustrine and drift clays, which affords a good water in nearly all cases.
4. The drift clay comes largely from the disruption of the marine Cretaceous clays, and that accounts for its greater alkaline qualities—while,
5. The lacustrine clay is a deposit of superficial fresh waters.
6. There is a water-bearing stratum in or near the bottom of the drift clay which is under considerable hydrostatic pressure, and water from it rises nearly or quite to the natural surface.
7. Nearly all of the wells in the Red River Valley are curbed with wood of some sort, generally pine.
8. This wood undergoes rapid changes due to the chemical reactions between organic acids and alkaline waters, as above described under natural circumstances.
9. This source of foul odors is abundantly sufficient to account for all the phenomena.
10. The organic matters cannot come from the lacustrine clay, because the odors are equally prevalent all over the western part of the state where no lacustrine clay is found.
11. These organic matters cannot come from the drift clay, because they are found in wells that do not enter the drift clay.
12. Any organic matter in either of these clays would have long since passed through the stage of decomposition necessary for the production of such gases, and entered into a carbonaceous and fixed condition.
13. The assumed cause of these odors, whatever it be, must be one that is coextensive with the effects—hence,
14. They cannot come from surface indrainage, since they occur in wells where that is impossible.
15. They cannot come from sewerage or other artificial underground sources, because they occur generally in wells where such contamination is impossible.
16. This fermentation of the sap and pitch of the pine sometimes has the effect of giving the less alkaline waters of the valley, in its incipient stage, a taste as of kerosene, and the appearance of small globules and films of oily consistency and spacific gravity floating on the surface.
17. The effect of this change may be obviated, or mitigated, by copious use of the wells; and it may be wholly avoided by using earthen or iron pipes, and discarding the wooden curbing.
18. Shallow, open wells, dug in the surface of the prairie and having alkaline water, may become offensive in the summer, though without curbing, by the decay of fine organic particles blown into them, or washed into them, from the rank vegetation of the prairie turf.

In the progress of this investigation the writer became impressed with the sufficiency of pine wood to produce such odors, by a simple test experiment; viz:

Two quart glass jars were filled with good well-water, not alkaline, taken from the same well. Into one was put a quantity of pine chips, but into the other nothing was placed. They were exposed to the atmosphere of the same room, the glass stoppers being inverted and loosely placed over the wide mouths. While the jar with nothing but clean water remained clear and inodorous during the continuance of the trial, and indefinitely thereafter, the other went through the changes indicated by the following.

Records.

Dec. 4. Place a quantity of seasoned pine sticks in a wide-mouthed glass jar in common well water. The jar stands on a table in a warmed room, loosely covered by the inverted glass stopper. The sticks all float.

Dec. 5. A portion of the sticks have sunk to the bottom of the jar, and small bubbles of some gas adhere to some of them.

Dec. 6. Nearly one half of the sticks have settled to the bottom. The jar when uncovered smells strongly of fresh pine. Gas bubbles are more numerous.

Dec. 7. There is no noteworthy change.

Dec. 8. There is no noteworthy change, except perhaps a stronger pine odor.

Dec. 9. The pine smell is very strong, and less fresh.

Dec. 14. A thin scum floats on the surface. There is an odor of sourness.

Dec. 19. The floating scum begins to settle, some of it swimming in the water.

Dec. 21. The scum on the surface adheres to the glass, and looks gummy. The odor is less sour, and somewhat offensive.

Dec. 25. The odor is offensive, and there is a gelatinous gum adherent on the glass, and along the water level.

Dec. 28. The odor is strongly offensive.

Dec. 31. The odor is very offensive and foul, as from organic decay. There is a white, gelatinous or gummy scum, as of fungoid growth, adherent on the glass about the water level, and floating in flocks on the surface. It sometimes appears, especially on disturbance of the jar, in globular masses of ⅛ to ¼ inch in diameter.

Jan, 1. The microscope reveals great numbers of organic germs, which are oval in shape and appear to be of the *Ciliata*.

Jan. 10. A jelly-like fungus, about a quarter of an inch thick, floats about in the water and on the surface. The odor is very offensive.

May 1. There is a swimming fungus which tends to settle to the bottom of the jar. The water is slightly turbid, and yellowish-red. It has a musty smell, and also is plainly acidulated. The microscopic animals are equally abundant, and of various forms.

In the presence of such a source of organic decay and contamination found in nearly every well in the whole region, it is evidently unnecessary, and even absurd, to search for any other.

These considerations bring up the whole question of the prevalence of typhoid fever as an endemic disease in western Minnesota and Iowa, but it is not germane to this report to enter on its discussion. Nothing more can be done here than to call the attention of those interested in the sanitary condition of the state to these facts, and to suggest that possibly the climate has less to do with such diseases than has been imagined, and that probably their causes lie nearer, and within the grasp of ordinary preventive measures. The effect of the water is not always an immediate typhoid fever, but an aggravated diarrhœa, and then dysentery, which lead finally to typhoid fever. This is the testimony of Dr. J. C. Rosser, of Brainerd, and also the experience and observation of many others. Sometimes the fever assumes a local name. At Bismark it is known as the "Montana fever." In Moorhead it is known as the "Red river fever," but they seem to be all essentially typhoid fever.

III.

RECONNOISANCES.

1. *Into Wright County.*

Information having been received from Hon. William Pfænder of the existence of some evidences of coal in Wright county, an examination was made of the designated localities. On Sec. 33 T. 119 N., R. 25 W., land of John Marth and Fred Wanderzee, along the north branch of Crow river, pieces of Cretaceous lignite have been found in considerable quantities; also, along a creek, Sec. 25 T. 119 N., R. 26 W., on land of Joseph Plant. These are all float pieces, exactly similar to what have been found in numerous other places, though perhaps more abundant. An examination was made in company with Mr. John Marth, of Delano. The banks of the streams are composed entirely of drift, and largely of blue hardpan. The lignite was seen in the bed of the creek, having been most observed at or near fording places, where it was most likely to be brought to the surface and seen by passing travelers. At no point could any Cretaceous beds be seen *in situ*. Along the stream are numerous pieces of slate, or fissile shale, likewise derived from the Cretaceous, though here immediately from the hardpan drift. It is possible that Cretaceous beds would be struck below the drift, in sinking a shaft.

2. *In Rice Connty.*

In company with Prof. L. B. Sperry, a number of localities of rock-outcrop were visited in Rice county, for the purpose of determining the main characters and the continuity of the Trenton and Shakopee. The details of the geology of this county are given in the report of Prof. Sperry, and it would be simply repetition to give them here. The most interesting observation made, was the discovery of a carbonaceous layer in the Lower Trenton, exposed along Prairie creek, which without previous drying will ignite from a common match, and burn with a flame.

3. *In Goodhue County.*

The examinations made in Goodhue county were in company with Hon. H. B. Wilson and Dr. W. W. Sweny, and consisted of a visit to the quarries at Wanamingo, Zumbrota and Red Wing, and the collection of two boxes of specimens.

The eastern part of the county is rolling, with frequent rock exposure in the brows of the hills, but the chief covering of the rocks is the loose loam with a thickness of 50 to 75 feet, sufficient to make the ascents generally tillable, while in the western portion the drift prevails so as not only to fill up the old rock-canons, but to convert the surface into an undulating prairie. The drift gradually thins out eastward under the loam. It seems to have suffered extensive denudation by aqueous forces, so that what is left of it visible under the loam is coarse and gravely or stony. A very large boulder of red or flesh-colored granite projects above the surface of the loam on N. W. ¼ of section 29, in Belle Creek. It lies on high land, and is conspicuous from a distance. It rises about nine feet above the ground, and has a circumference of 26 paces. It belongs, of course, to the old drift epoch, and not to the last, as it is embraced in and partly covered by the loam, the loam not having covered generally the newer drift in that part of the state. It is evident that the denudation to which the old drift-surface was subjected, produced the material for fine clays which gathered in quiet spots, since under the loam, in old canon-valleys, and also in some places less protected, there are extensive laminated clays. The Red Wing pottery-clay comes from below the loam, on Sec. 3, Goodhue, Goodhue county, and has a light gray, bluish color. The whole excavation was unfortunately covered by water, and nothing could be learned of the relation it bears to the drift or the loam. The Terra Cotta clay, of Red Wing, is the blue interior of the terrace that accompanies Hay Creek. It is in horizontal laminations, and upwardly passes gradually into the loam. Between the two drift periods it seems that the country had a forest covering, since in Goodhue county, no less than in Fillmore and Olmsted, there are abundant remains of timber and of the old soils. On Sec. 2, Wanamingo, on the high prairie, land of Wm. Boulett, a log of what appeared to be hemlock, or coarse pine, was found in digging a well, at the depth of 26 feet below the surface. This was embraced in a "bluish-blackish" clay, apparently a soil, and was five or six inches in diameter. It was covered with a hard, gravely, yellowish clay and by the loam that covers that part of the county. Also on Sec. 5, Belvidere, land of John Holtz, in the valley of the creek, was found wood twenty feet

under the surface, in the gravely blue clay, or under it. On Sec. 24, Chester, Wabasha county, a log a foot in diameter was found in digging a well, upon the high prairie, said to be about twenty feet below the surface. This log was well preserved and could be chopped. It lay on the ground near the well for some years.

At Wanamingo the Lower Trenton is quarried in a low bench along the Zumbro. This bench rises higher and higher above the Zumbro in descending the stream, and finally the St. Peter sand rock appears, and then the Shakopee limestone, which, at Zumbrota, supports the south end of the bridge over the river, rising about 25 feet above low water. The stone for the abutments and foundation for the Forest Mills was taken out of this rock near the mills; but the stone for the bridge at Zumbrota came from the Trenton in higher land near Zumbrota. The Forest Mills are about two miles below Zumbrota. The Shakopee here causes a terrace-flat on which is situated Zumbrota village, but there is a covering of drift-gravel and loam.

A few aneroids were taken at Red Wing, and a general section was obtained of Barn Bluff. The top of the bluff is covered with loam, which also hides the rocks from sight down a sloping descent of about 70 feet. If this be regarded as containing limestone the thickness of the limestone will amount to 120 feet. From the top of this there may have been destroyed several feet of limerock. The general section then consists as follows, in descending order:

1. Slope and limerock..........	120 feet.
2. Sand and green-sand, and limerock,..................	40 feet.
3. Massive sand, the upper portion being white, the lower portion yellow. From this the glass sand is taken..........	50 feet.
4. Sand and green-sand, with cement of lime and magnesia, with distinctly aluminous portions. To the flood plain..	80 feet.

Barn and Soren bluffs dip toward the east a few degrees. There are extensive quarries in these bluffs, that furnish a fine building material. The stone now being used in the bridge over the east channel of the Mississippi at Minneapolis is from the quarries of Mr. Carlson in these bluffs.

4. On the Northern Pacific Railroad.

The details of this reconnoisance, so far as they relate to the water supply for domestic uses, are given in the chapter devoted to *Water-supply of the Red river Valley.* The only rock exposure along the line of the Northern Pacific R. R. after leaving the neigh-

borhood of the Junction with the St. Paul and Duluth R. R., within the State, occurs in the vicinity of Motley. This is a range of granite, about four miles north of the station, on sections 21, 22, 27 and 28, extending north and south. It widens out toward the north before disappearing under the drift. Its extent is about a ¼ mile across from north to south. The country round about for miles is nearly level, and covered with Pinus Banksiana, *Lam.* It escaped the observation of the land surveyors of the N. P. Company, and the land was entered and described as having "no stone." There are here hills and ridges that rise fifty or seventy feet above the surrounding country, and in some of them the rock is bare. It cannot be said with certainty that this rock exists in all these hills and ridges, but it probably does. There are but few spots where any drift boulders can be seen, the country—even these hills—being covered with sand or sandy loam. The surface of the rock is old. It does not show recent glaciation, the appearance it presents being rather that that would be attributed to aqueous forces. The surface is, in general coutour, *moutonne-ed*, but not so markedly as the knobs and hills of Marquette and Duluth. Since this glaciation it is evident that water has covered this rock for a long period—water probably which spread the fine sand over so wide a belt, extending almost uninterruptedly from near Thompson to this place.

The rock rises in undulating sheeps-backs, and in the intervals is covered with sand and turf. It consists, taken all together, of at least three different qualities, viz: First, a gray syenite (?) which has a greenish mineral like serpentine and also both white and flesh colored pieces of feldspar, rather fine grained. Second, a dark, diorytic, trappean rock that occurs in apparent, wide dykes in the granite. This varies from a petrosilex, (or what may be taken provisionally for that rock) to a real dioryte. Third, a serpentinous granite, i. e. a granite (with white feldspar) that contains a green mineral undistinguishable from the green mineral of No. 1, with evident lumps of mica. These three kinds may not be the only variations that the rock will on quarrying exhibit, but they are the only noteworthy ones observed. They are all rather fine-grained. The green mineral of No. 1, is sometimes more abundant in streaks or veins, even two inches wide, than throughout the rock, giving the rock a striped aspect, often two or three thin veins coming within a foot. This rock was discovered and purchased of the N. P. R. R. by Mr. C. H. Alsop, who is beginning to open it for sale. Being in the midst of a country destitute of known rock, especially of granite, this locality has much importance. It will furnish a building material of the most durable kind, and possessing all the excellencies of the granite of St. Cloud or Sauk Rapids.

From Brainerd to Motley the country is about the same as at Brainerd, i. e., a sandy plain. The timber consists largely of Bank's pine. Wadena and Perham are on prairie openings. At the latter place the subsoil is a gravel-and-sand to the depth of at least 15 or 20 feet, as revealed by wells that get good water at that depth. This gravel-and-sand is like that on which Minneapolis stands, but is not overlain by so distinct a loess loam. The loam here is only soil-deep, and also contains occasional little pebbles, the same as found in the gravel below, showing that the loam is only a soil formed from the sand and gravel of the subsoil. This subsoil of gravel-and-sand continues westwardly, through and beyond the prairie on which Perham stands, and into a sparsely timbered and undulating country, even beyond Frazzee City. It is noticeably *free from boulders*, and consists only of gravel and sand. On approaching the Leaf Hills the gravel and sand becomes gradually coarser, with occasional stones, the general surface also becoming more broken. Further on the gray hard-pan, very stony, comes in, at first gradually as if the gravel and sand were horizontally merged into it by the accession of clay and larger stones, but finally so as to comprise the mass of drift, as seen in the cuts by the grade of the road. The hills are composed of this hardpan. At Detroit the surface is undulating and somewhat rolling, but mostly a prairie, being fairly on the west side of the Leaf Hills. There is a little timber west of Detroit, but the prairie sets in within a couple of miles, and continues to Moorhead. The subsoil at Detroit is the same as at Perham, a gravel and sand, the surface-soil being a loam, derived locally from the subsoil by disintegration and the action of vegetation. The roads are always dry; the wells go into gravel for water at the depth of 25 or 30 feet, the supply being good—limy or chalybeate—and copious.

Above Brainerd about five miles, are the French Rapids, in the Mississippi river. Their immediate cause is a quantity of drift boulders, which lie mostly along the left shore, though they are also of course throughout the bed of the channel; but their original cause is probably the nearer approach of the bed-rock toward the surface of the drift. A short distance above these rapids, on the left bank is a high drift bluff composed largely of clay, but containing numerous stones and boulders. Below the rapids the river runs along the left side of an alluvial, timbered island. The fall in the rapids is about three feet. No bed-rock can be seen. There are a few boulders also along the right bank just above the head of the rapids. The bottoms are covered with deciduous trees, but the upland mainly with Banks' pine, with some white and Norway pine.

East of Brainerd the country is mainly one of plains, which are superficially sandy, but they must be closely underlain by a clay deposit, since they often become wet, when large swamps are caused by the contained water. There are also numerous ridges of hardpan-clay soil and subsoil, in which a different outward appearance is very marked. The trees become larger, and consist of a greater proportion of deciduous species, while the Banks' pine entirely or almost wholly disappears, and the Norway and white pines prevail. Toward the Junction the hardpan clay comes in in full force and continues to Duluth, except when overlain by the red laminated lacustrine clay of Lake Superior.

At the Northern Pacific Junction, prominent and bare ridges of slate, four to six in number, rise about 25 to 40 feet. They run nearly E. & W., or by compass north 80 degrees east, varying to north 75 degrees east. The slaty cleavage runs nearly parallel with the direction of the ridges, or north 85 degrees east. In approaching from the west, along the N. P. R. R. this slate becomes perceptible a short distance before reaching Komoko; and, by the topography and changed drift, rock is evinced for several miles even before reaching that place. These ridges run through Komoko and the N. P. Junction, and at least to Thompson, where they have been wrought, the slate quarries being about two miles from the railroad in Sec. 29, T. 49 N., R. 16 W. They are not continuous, nor uniform in height nor in length. They rise, and sink again below the surface, with an irregular alternation. Sometimes a section across the range would show only three or four series and sometimes there might be six. Often the intervals in one series are opposite the ridges in the adjoining one. The rock itself varies from an argillyte suitable for roofing, to a very dark, or gray quartzyte that shows less slaty cleavage, yet must probably be taken as a part of the same slate group. The rock of this latter kind seems to be found in some of the ridges exclusively, while the argillyte prevails in others. Outwardly they have about the same appearance, as they lie in long parallel, undulating ridges, and perhaps they should not be so prominently distinguished as this description implies. These ridges are moutone-ed, but there are no scratches or other marks showing the direction of any glacial action. They have three systems of jointage planes crossing each other at various angles, so that the rock itself is cut into large angular blocks to great depths, which not only facilitates the quarrying of the slate, but the natural disintegration of the ridges by frost. The adjoined sketch shows a ground plat of one of the ridges, with the different systems of joints:

FIG. 2.

Ground plat of a slate ridge at Junction.

Explanation of Figure 2.

1\. 1. Slaty cleavage, nearly perpendicular, runs north, 85° east.

2\. 2. Joints that cut the slaty cleavage at right angles, but slope west at an angle of about ten degrees from a perpendicular. They are sometimes so numerous as to number four or five in the interval of a foot.

3\. 3. Joints (or bedding) which run parallel with the ridges, but slope south at an angle of about 45° with the horizon. The southern slopes of the ridges are formed by the splitting off of the layers, while the northern slopes are apparently caused by the breaking off, by an irregular and shifting fracture of the same layers, and have an angle about the same as the southern slopes, but in the opposite direction.

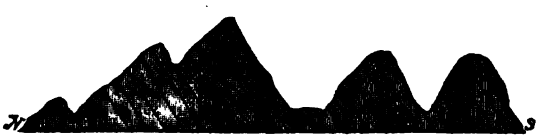
4\. 4. Less distinct oblique joints that do not seem to be as numerous as the foregoing, but which, on the quarrying of the rock, are seen to penetrate to as great depth. These aid in causing the superficial parting of the rock into rhomboidal and angular masses. They slope N. W. at an angle of about 25° from a perpendicular.

The horizontal extent east and west is about six rods.

Figure 3 is a perpendicular section running north and south across these ridges, showing the direction of the slaty cleavage and of joints 3. 3. of Fig. 2.

This slate appears to be the same as seen at Little Falls, on the Mississippi below Brainerd, but it here shows none of the concretionary hornblend, or dioryte rock, and, taken all together, is somewhat finer grained, not showing an evidently micaceous composition.

FIG. 3.



Section across the slate ranges at Junction.

IV.

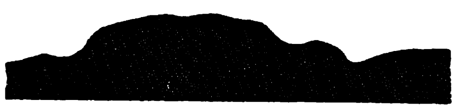
THE GEOLOGY OF MORRISON COUNTY.

This reconnoissance was made in company with Mr. N. Herrick, of Minneapolis. The first observations were made at Pike Rapids, which are at the mouth of Swan river, but are in the Mississippi. They are so named from Lieut. Z. M. Pike who built a stockade and wintered with his men here in 1805–6. They are caused by a mica schist rock which rises in some spots about six feet above the water at low stage, but lies mainly in the river channel. The only outcrop on the shore seen being in the left bank. The schist is filled with small crystals of garnet and coarse crystals of staurolite. Besides these clumps of schist rock rising in the channel of the river, there is an abundance of boulders of all kinds, both in the river and on the shore, the banks rising about 30 feet and consisting of coarse material. The rock itself seems to dip, at least it has a laminated structure which dips, toward the northwest at an angle of about 45 deg.

At Little Falls the rock that occurs in the river is a roofing slate similar to that at Thomson, but varies from a mica schist to an argillyte, with some veins of white opaque quartz. The rock in some places also varies to a massive, compact hard rock with sharp jointage angles, whch, when broken, has nearly the color and texture of the staurolite crystals, if fractured. found in the rock at Pike Rapids, but seems to be more nearly a dark quartzyte. Besides these variations there are nearly continuous layers of more or less lenticular and concretionary lumps or nodules, sometimes six or eight inches thick, of a rock very firm and dark-colored, but which on weathering becomes superficially lighter-colored and shows needles and spangles of dark-green amphibole. The matrix in which these crystals lie is not well characterized, but is quartzytic and perhaps also feldspathic, but is dark-colored, so that on a fresh

fracture the amphibole crystals are hardly observable. They appear on the weathering of the rock. By far the greater part of the whole is a micaceous argillyte, with slaty cleavage nearly perpendicular, or sloping a very little toward the N. W. (N. 18 deg. W.), the strike being N. 18 deg. E. There is also a system of joints that gives the rock, viewed across the river, the appearance of being conspicuously stratified, with a dip up the river of about 45 deg. from the horizon. The slatiness, which is nearly perpendicular, is somewhat injured, at least superficially, by the frequency of joints, of which there are at least two systems intersecting each other at a small angle, thus cutting the slates into rhomboidal masses, as they weather to pieces. The following diagram (Figure 4) is designed to show the relation between the slates and the three systems of joints mentioned. The general exposure is an irregular expanse in the river channel, and bottom land, but does not rise in ridges or knobs, though the occurrence of a dyke of dark trap, and the massive quartzytic rock, seem to have been the primary cause of this protrusion upward of the underlying formation which is generally more deeply buried under the drift. This is known to extend under Little Falls village, being encountered in wells and cellars.

FIG. 4.

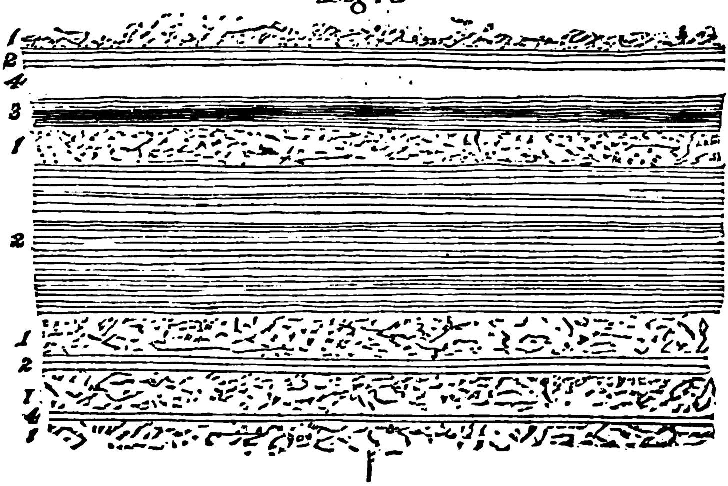


Jointage of the slate at Little Falls.

A little distance further down the river, yet scarcely outside the limits of the village, rock is exposed on "the point," and consists, in general, of a hard, dark-colored dioryte, containing mainly amphibole in coarse crystals, and a little feldspar (labradorite?). The outward characters of this rock are the same as the concretionary lumps that exist in the slate already described. It is here simply in larger area and bulk. It is parted by joints that cause it to fall to pieces in slabs and cuboidal masses. This *may be* here in the form of a dyke, but its relation to the slate cannot be seen. The point which is formed by it is considerably higher than the bottom land on either side, but falls away somewhat on receding from the river, the rock itself becoming lost to view in the swampy bottoms, or involved with the drift of the river-bluffs. On long-weathered surfaces, under the action of the water, there is a ridged and furrowed form that shows the same direction and trend as the slatiness of the slate, i. e. N. 18 deg. E. These ridges are about ½ inch apart, and about ⅛ or

¼ inch high, separated by intervening furrows. This surface configuration is apparently due to the alternate arrangement of the mineral contents, and perhaps has its origin in a metamorphosed condition of the slate itself, or of the sedimentary rocks from which they both may have been derived. Thus this could not be of the nature of an igneous dyke, but a metamorphic variation due to the complex nature of the original sediments. This view is strengthened by the occurrence of a similar diorytic rock, in concretionary masses, in the slate itself, running in more or less regular layers or lines. This alternation of mineral contents does not pervade the whole of rock exposed on "the point," but it is a conspicuous feature in some places. The ridges are composed of the lighter colored minerals, and the furrows of the amphibole. The adjoining figure (Fig. 5.) illustrates the alternation of these ridges and furrows.

Fig. 5



Arrangement of Mineral Contents at Little Falls.

Explanation of Figure 5.

1. Bands of dioryte.
2. Alternating bands of amphibole and feldspar.
3. Furrow mainly occupied by a band of amphibole.
4. Feldspar band.

Opposite the village of Little Falls a trap dyke of basic doleryte, apparently about 10 feet wide, appears in the slate, going diagonally across the slate; and on the south side of the dyke, in the lee of its protection against the current of the river, as well as against, possibly,

the ice of the ice-period, the slate (or schist) is decomposed to the depth of four or five feet at least, making a greenish-blue clay, or incipient kaolin.

The slate at Little Rapids is visible, along one or both sides of the river, as far up as the ferry, perhaps three-quarters of a mile above the village.

On the N. E. ¼ Sec. 13, (R. R. land), Little Falls town, on the west side of the river, is an area of dark granite, rising in smooth knolls a few feet above the surrounding country, which is flat and rather wet, though sandy, and in fact is an eastward continuation of the flat of the west bank of the river at Little Falls. This rock is not in all places a true granite, but varies to a dark, apparently trappean rock, which is an amygdaloidal melaphyre*, containing, however, a light-green mineral like serpentine. There are also variations to a non-amygdaloidal melaphyre with scattering mica-scales.

At the mouth of the Little Elk river, two and a half miles above Little Falls, the slate seen at Little Falls again appears, but here the direction of the slatiness is N. 30 deg. or 35 deg. instead 18 deg. east. The creek runs across it and cuts into it. The dam is made between the rock bluffs on either side. The slate is known to extend up the Little Elk only about half a mile.

N. E. ¼ section 26, Belle Prairie. Here is an outcrop of granite. It rises not more than eight or ten feet above the general surface, which is nearly level. It is rounded over but is not striated. Its color is sometimes pink and sometimes gray. It is rather massive than schistose. Its area probably extends over on the next section north. Similar rock occurs again about two and a half miles northeast of this place on section 18, in the next town east.

PRIMITIVE MAN AT LITTLE FALLS.

(1). The Stone Cutters.

During the examination of Pike Rapids some search was made for Pike's winter stockade. Near the principal exposure of the bed-rock, along the east bank, abreast of a small island scantly turfed over, there is a blind excavation in the river-bank which consists of loose

* This term is used here in the indefinite sense preferred by Bernhard Von Cotta.

sand and fine gravel, that has the appearance of having been artificial, but no old timbers could be found in the vicinity. Paris Roy, a half-breed living at Little Falls, says he remembers hearing his uncle, a trader for the American Fur Company, named Charles La Rose, stationed seven or eight miles above Little Falls, at that time, relate the fact of Pike's stopping here and describe the place as on the east bank, and below the rapids. This excavation is really below the main rapids, though there is half a mile of rapid water below it, caused by boulders, without exposure of the bed-rock.

About this excavation, which may or may not have been the site of Pike's stockade, are pieces of chipped white quartz, which from their sharpness, and their color, indicate an artificial origin, and attract the eye of the visitor. It was only after a handful had been gathered, that at last an imperfect arrow-head was found. These chips, at this point, were found only over a small area, indeed they were not looked for at other points up or down the river, nor at any depth below the surface. This quartz, which is white and opaque, was evidently taken from some vein in the slate in this neighborhood, for the slate at Little Falls has several veins of that kind of quartz.

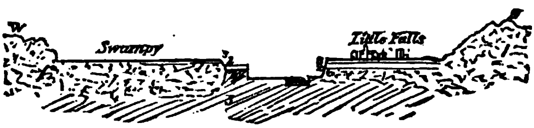
Subsequently however, these chips were found to extend over a larger area, and to be incorporated with the materials of the river banks. Further examination at Little Falls disclosed this interesting discovery. They are found, not only on the surface of the flat on which Little Falls village stands, especially near the river, but on excavating the bank near the river, making a perpendicular section, they are found to extend downward three or four feet into the sand and gravel. A person in digging half an hour might find twenty-five or thirty. The material in which they occur is a homogeneous sand, passing downward gradually into a coarse sand and finally into a gravel. This flat along the river on the margin of which they are found, is about twenty-seven feet above the river, and is now never covered by it. The bank itself may be divided into three parts, as follows, in descending order:

1. Loam sand, gravelly below.
2. Gravel, becoming stony below.
3. Hardpan-drift, containing boulders.

The plain on which Little Falls stands, is about a mile wide, and extends along the river; as an abandoned ancient flood-plain, southward, and becomes that on which East Minneapolis is situated. Toward the south its average width remains about the same as at Little Falls—perhaps becomes less—but toward the north it increases in width, and at the same time rises above the river, and finally

comes apparently to constitute the entire country about. Brainerd (with the sandy country east of it) is on such a plain; towards the west a sandy plain of the same nature, and the same level extends much further, though, opposite Little Falls, it is occupied to a large extent with wet land and often by tamarack swamps. On either side of the river, outside of this plain, is a line of drift bluffs which have a rolling coutour and rise from 50 to to 75 feet higher, constituting a greatly different character of country, and occupying the general level for an indefinite distance east and west from the river. Northward from Little Falls, while the included plain becomes wider, and covered with a coarser sand, these bluffs gradually become lower. It seems as if the plain slowly rises to the level of these drift-bluffs, and the bluffs themselves then are lost to view, or are so broken, and involved with other drift knolls and ridges, that they seem to have no relation to the river itself. In traveling by the new railroad, lately constructed between Brainerd and St. Cloud, this change is observable. The road itself, at least between Little Falls and Brainerd, runs throughout on this plain. In reverse order the depth of the river below this plain increases in going northward. At East Minneapolis it is from 25 to 30 feet above low water; at Shingle creek it is about 37 feet; at Champlin it is 43 feet; at Dayton 45 feet; at St. Cloud 58 feet; at Brainerd about 60 feet. No measurements have been taken above Brainerd. Along the river at a lower level is another flat, or bottom-land, which is the present flood-plain. The hardpan drift which prevails in the bluffs on the east side of the river, and which underlies the sandy plain above described, seems to be of the old drift epoch (see report on Hennepin county for 1876), and lies on the slate at the Falls. The adjoining diagram (Fig. 6) represents a section across the Missississippi valley at Little Falls:

FIG. 6.



Section across the Mississippi valley at Little Falls,

Explanation of Figure 6.

1. Hardpan drift, on the east side covered with a fine clayey loam.
2. Gravel and sand.
3. Sand, loamy above and gravelly below; 60 feet above the river at low water.
4. Trap dyke.
5. Slate rock.

The quartz chips occur in No. 3, and abundantly on the flat (somewhat lower than the average here) directly opposite Little Falls, in the neighborhood of the trap dyke. They extend up and down the river also an unknown distance. They were found at the mouth of the Little Elk, two and a half miles above Little Falls. The belt on the west side which seems to afford them is about 40 or 50 rods wide, but something less than ¼ mile on the east side. On the west side they appear in the soil when large trees tear it up.

These chips are all angular, some of them being as sharp as knives, and perfectly unwaterworn, and they occur in a waterworn deposit. They vary in thickness from that of paper, and the size of one's fingernail, to one and two inches across, of irregular, angular forms. Almost no other coarse material is found in the surface sand in which they are found; and whatever there is, is waterworn and rounded. The chips are generally without evidence of designed form, and nearly all the angular pieces are also destitute of all evidences of artificial shaping, so far as their forms are concerned. Only a few pieces were found that seemed to show the work of careful chipping, and they are not perfect. The most certainly chipped form found was taken at Little Elk river, but was of brown chert. Some of these chips are represented on Plate I.

The interest that centers in these chips, and which alone would warrant this extended account of them, involves the question of the age of man and his work in the Mississippi valley. When they were first observed they were taken to be of much later date than they seem to be, indeed they were associated with the builders of the mounds and ridges that are seen at Little Falls and many other places in Minnesota, attributable to a race known as the Mound-Builders, who preceded the present Indian races. But these mounds and ridges at Little Falls are built of the very sand, and are situated on the very same plain in which these chips occur. In other words, the Mound-Builders dwelt at Little Falls since the spreading of the material of the plain: hence they are post-glacial. The chipping race, if these chips are of human origin, preceded the spreading of the material of the plain, and must have been pre-glacial; since the plain was spread out by that flood-stage of the Mississippi river that existed during the prevalence of the ice period, or resulted from the dissolution of the glacial winter. The fortunate juxtaposition of these two classes of human remains enables us to establish this important general truth. The wonderful abundance of these chips indicates either an astonishing amount of work done, as if there had been a grand manufactory in the neighborhood, or an enormous lapse of time for its performance.

EXPLANATION OF PLATE.

(*See Page 56.*)

FIG. 1, *a*. Convex surface of a chert implement found at the mouth of Little Elk river, Morrison county, supposed to be a scraper.

FIG. 1, *b*. Profile view of same.

[NOTE.—This specimen is regarded a finished implement by F. W. Putnam, of the Peabody Museum.]

FIG. 2, *a*. Convex surface of a chert implement found at Little Falls.

FIG. 2, *b*. Profile view of the same. The figures do not perfectly represent the evidentally chipped edges.

FIG. 3, *a*. Broken arrow-head (?) of white quartz, found at Pike Rapids.

FIG. 3, *b*. Profile view of same.

FIG. 4, *a*. Scraper (?) of white quartz, from Little Falls.

FIG. 4, *b*. Profile view of same.

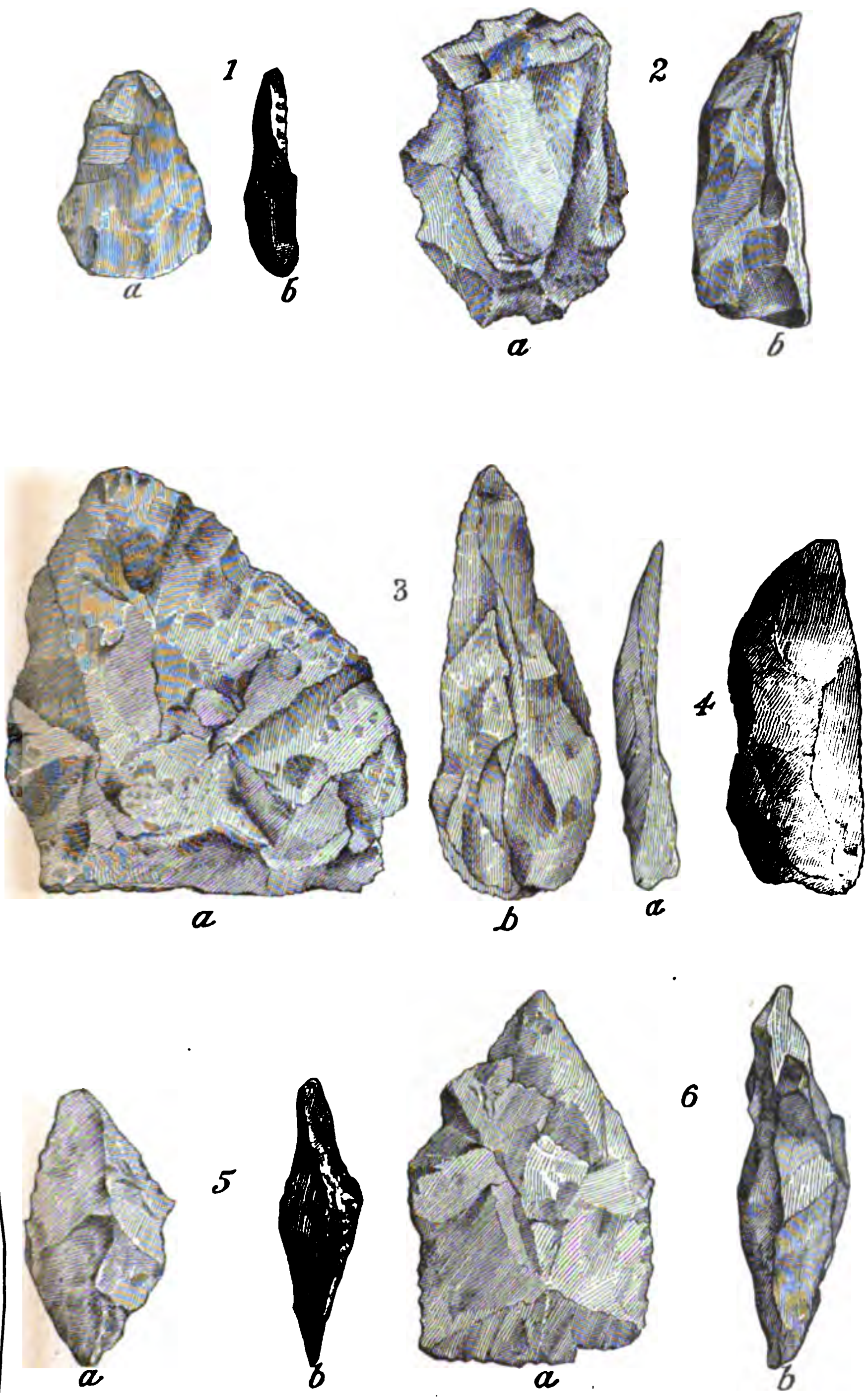
FIG. 5. *a*. Implement of white quartz, Little Falls.

FIG. 5, *b*. Profile of the same.

FIG. 6, *a*. Implement of white quartz, Little Falls.

FIG. 6, *b*. Profile of the same.

These figures are all of the natural size of the specimens.



C. L. Herrick. Del. PHOTO. ENG. CO. N

There is one other source to which these chips can be referred. The veins of white quartz traversing the slate at Little Falls, from which these chips were originally derived, were observed in one instance (near the mouth of Little Elk river) to split into angular pieces similar to those taken from the surface sand of the plain, under the action of moisture and frost. This was seen at a point where the freshet water of Little Elk river had lately carried away the surface materials, laying bare a large area of the slate. The quartz of the vein, not having a mineral cleavage, yet had an irregular fracturing tendency which resulted in the disentegration of a considerable quantity of the vein. It is supposable that in some earlier history of the river, when it was large enough to cover the whole valley from the drift bluffs a mile east of Little Falls to the drift bluffs several miles west, this same disintegration under natural causes took place, and that by some means the fragments were distributed by the water of the river, perhaps by floating ice, over the flat on which they are found when it was the bottom of the river. This supposition meets with the following obstacles.

1. There is no point throughout the whole region round about where the slate conveying these quartz veins rises to the level of the surface of this plain so as to be within the range of transporting agencies, whether of the water of the river or of floating ice, but the quartz veins are from 40 to 50 feet lower than the flat on which the chips occur.

2. During the high stage of water that formed the chip-bearing terrace, that plain itself was intact from side to side, the present river channel which is cut down to the slate and the quartz veins, not having been excavated.

3. The chips seen at Little Elk river, resembling these supposed human remains, were in the bed of the river, and *under* the drift originally, even the unmodified glacier drift, while the transported chips are *over* the glacier drift and in a water-washed sand.

4. If these chips were the product of natural disintegration, and river distribution they would be expected to show some attrition incident to the long period of wearing they had passed through. On the contrary, while embraced in a water-washed and rounded sand, or fine gravel, they are themselves not worn in the least.

5. The quartz fragments, while mainly destitute of evidence of designed shape, do in a few cases appear to be imperfect forms of arrow-heads or of cutting or scraping instruments, and also have, along the edges, the appearance of having received repeated blows, and present small fresh surfaces of forced fracture.

6. In gathering about three quarts of these chips, eight pieces were found that could be thought to have a designed form, and two of these are of brown chert and undeniably the product of human design.

(Since the foregoing was written, some of these chips have been submitted to Mr. F. W. Putnam, Curator of Peabody Museum of Archaeology and Ethnology, Cambridge, Mass. After an examination he says he has no hesitation in saying that he "considers them identical with those known to be formed by the hand of man when making implements of stone." One of the chert specimens he regards "a finished implement.")

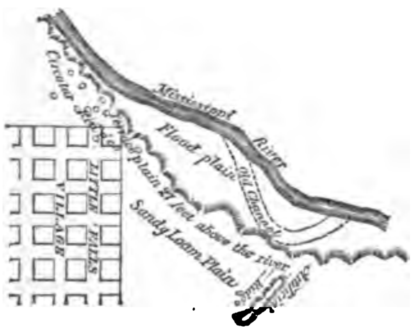
(2.) The Mound Builders.

Mention has already been made of ridges and mounds on the terrace at Little Falls attributable to the early race known as Mound Builders. They have a general resemblance to many others that may be seen in the State, some of which have been alluded to in former reports (Reports on Houston and Hennepin Counties). Their occurence at Little Falls is interesting especially in relation to the possible human origin of the quartz chips that have been described, as they seem to be of later date than the chips. This is proven by the fact that the mounds are built on the terrace plain, and of its materials, in the composition of which plain the quartz chips take part, extending three or four feet below the surface. The mounds themselves are somewhat different from those seen elsewhere, inasmuch as they consist of low, circular ridges, from eight to twelve feet across, rising but two or three feet above the general level. These are scattered over a small distance on the east bank of the river near the northwest corner of the village plat, though perhaps others would be discovered on making a more extensive survey. The following diagram of the surface shows their position relating to the river and the other ridges. They may have been designed for habitation, having been formed at first by slightly excavating the surface of the ground, and then building rude arched coverings supported by wooden branches and enclosed by earth. As these decayed and fell in, the resulting forms would be exactly what are now seen. Beyond the limits of the village, further north, is an interesting ridge, nearly straight, running obliquely back from the river and a hundred and eight paces in length. This is of a very different nature, though plainly artificial. It is from three to four feet high. It has two low spots, or openings through it, which separate it into three main parts. It does not extend to the imme-

diate river bank, but is separated from it by an interval of several rods. The design of this ridge is not evident, but it must have had some relation to other works in the neighborhood. It may not however, have the same age as the small circular ridges above mentioned, since there is some possibility that the latter may have been built by the present Indian races.

About fifty earth-works or mounds are found on the border of a small lake on Sec. 35, Belle Prairie and Sec. 9, Little Falls, six miles east of the village of Little Falls. They follow round the shore of the lake, which is know by the Indians as "The Lake between the Hills."

FIG. 7.



Mounds and ridges at Little Falls,

(3.) *In other parts of Minnesota.*

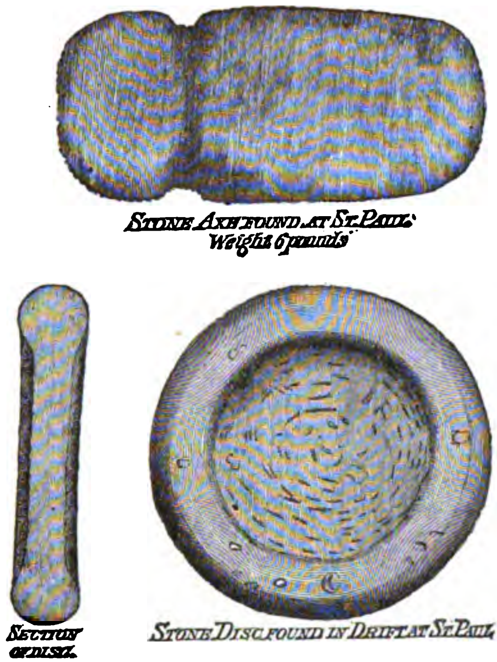
A great many flints and stone implements have been found in the State indicating the former prevalence of a race, or races, analagous to the stone-workers of Europe. Whether these stone implements are referable to the older stone-working race, which would make them pre-gracial, (palæolithic), or to the more recent nolithic stone-workers, or to both of them, has not yet been ascertained; but the disposition has been general to assign them to the latter. It may be possible, however, that the palæolithic race is represented, and the quartz chips at Little Falls would seem to indicate that to be the case. At any rate the most careful attention should be given to the relation of all such discoveries to the drift of the region in which they occur.

A few of the other evidences of palæolithic man in Minnesota may be mentioned. Dr. A. E. Johnson mentions in the Bulletin of the Minnesota Academy of Natural Sciences for 1874, the discovery of human bones in the sand and gravel of the Mississippi river in

the eastern terrace bluffs, at Minneapolis, coincident in age and hight with the terrace bluff in which the quartz chips occur at Little Falls, this being a deposit coincident with or immediately following the last glacial epoch. On the same authority two fragments of a human lower jaw with teeth were discovered in the "red clay and boulder drift" near the Falls of St. Anthony, by workmen excavating in it for use in the tunnel under the river, lying "immediately upon the limestone ledge." This red clay is the product of the first, or oldest known, glacial epoch, and lies below all the other drift. He also states that on the same side of the river a copper spear-head was taken from a crevice in the limerock of the Lower Trenton, where its strike forms an elevation in the alluvial plain of the terrace above mentioned, at some distance from the immediate river, under four feet of drift—"sand, gravel and clay"—which is now in possession of the St. Paul Historical Society. This deposit is of the same plain and date, as the material of the terrace containing the quartz chips. The spear-head is said to have been three feet within the lime-rock. It must be admitted, however, that, supposing these human bones and teeth to have been found in the manner reported, they may still have been the result of more modern burials, and the spear-head may have been thrust in the crevice (a weathered and eroded jointage-plain) horizontally, instead of perpendicularly, as these open crevices abound in the Lower Trenton and appear on the exposed wall of the rock facing the river, and especially in that part of the ancient channel which was cut prior to the last glacial epoch, where this spear-head was found. The locality of the Falls must always have been a resort for rude tribes of men, and a great many burials, not to say battles, may have taken place here. Still there is an appearance of authenticity about these discoveries, so far as the published facts go.

A stone axe weighing six pounds was found at St. Paul in digging a cellar near the Adams school house, by Jacob Biska, six or eight feet below the surface. It was overlain by soil and black loam, which has a thickness of eight or ten feet at that point. The figure below shows its outline. The surface of the blade end is smoothed, or roughly polished, but the other end is rougher, or weather-worn. This lay in the latest of the drift deposits, but far beyond the reach of the present river, though within the outer drift bluffs.

FIG. 8.



Stone axe and disc found at St. Paul.

In a gravel bank at St. Paul also was found recently by Mr. Mervine, a stone disc about two inches in diameter, and three-quarters of an inch in thickness. This has a circular depression in the center. One side is coated with a limy crust. It is of a fine-grained greenstone.

The remains of an extinct elephant, in the form of a tooth and tusk, were found in the gravel and sand of the east bank of the Mississippi about five miles above Minneapolis. These occupy the same relation to the river and the valley as the quartz chips at Little Falls, having been taken from the same terrace.

In the coarse river-gravel at Stillwater, far above the present river, but within the main valley, was found a mastodon's tusk, and about eight feet of it are preserved in the Academy of Sciences at St. Paul. This was taken out in the year 1856 by A. Van Vorhes. The section of the bank in which it was found is now made up as follows:

1. Disturbed sand with some boulders.................. 5 feet.
2. Fine sand, with nearly horizontal strata............... 2 to 6 feet.
3. Gravel and boulders.................................. 0 to 4 feet.
4. Very fine, handsome sand, in horizontal stratification... 15 feet.
5. Coarse gravel and boulders......................... 4 to 6 feet.
6. Horizontal strata of fine sand......................30 to 40 feet.
7. The "tripoli" bed lies next below this fine sand.

The tusk was found in No. 6, and near the bottom. Near the top of the same stratum, Mr. Van Vorhes found fragments of pottery having carving and ornamentation. These are all to be seen in the Academy at St. Paul.*

In the possession of the Minnesota Historical Society are two immense stone hammers recently obtained at St. Peter by Mr. B. M. Randall. One of these was found four feet under ground, and the other was on the surface. They each weigh fifty or sixty pounds. The adjoined sketch of their probable manner of use represents, if correct, probably the most primitive flouring-mill that Minnesota ever possessed. It was prepared by Dr. R. O. Sweeny. While these millstones each have a groove running about them, somewhat on one side of the middle, as if for receiving a withed frame, yet the groove of one appears as if it were of natural origin, and caused by the more rapid disintegration of a vein of micaceous granite or gneiss with which the groove is coincident, while the bulk of the stone is of a firmer rock. In the other, however, the groove has evidently been dug out by coarse artificial chipping.

These *upper millstones* were found at points two miles separate. One, the larger of the two, has the groove deep on one side, but less

*The importance of this "find" caused the writer to distrust his own notes, made in 1872, as to the exact position of the pottery, although taken down on the spot as described by Mr. Van Vorhes, and to make a fresh application to Mr. Van Vorhes for the particulars as to its *exact position*. The following from that gentlemen, who is an experienced surveyor and an exact observer, affirms the position of both as at first stated :

STILLWATER, April 26, 1877.

DEAR SIR :—Yours of the 16th came duly to hand, and found me almost helpless with a rheumatic attack, which explains my seeming neglect to answer your inquiry.

The mastodon tusks were found about eight or ten feet above the base of the hill : the hill at this point rises at an angle of about 45°. After excavating in the base of the hill on the grade of Myrtle street about 37 feet, the tusks were found, consequently 37 feet below the surface. At this point the hill was about 90 feet high.

The crockery I found some thirty feet farther into the hill and some six or eight feet higher in the strata. This hill is a continuous tongue of land lying between the Florence mill stream and a spring run. The two streams run parallel and some 350 feet apart. The hill is so steep on the Florence mill side as to be inaccessible except by clinging to roots and brush growing on it. The material at the base is sand and small gravel. Where the tusks were found the strata were pure sand ten or twelve feet thick, exhibiting clearly the direction of the current in an eastward inclination one or two degrees. On the top of the hill were heavy boulders of the drift period. I deeply regret that indisposition and the weight of eighty-four years have rendered me incapable of composing a satisfactory commmunication. Yours, with much esteem,

A. VAN VORHES.

noticeable on the other, and was found in 1876. It lay "under the ground, covered with black earth and sand, above a layer of chalky deposit containing some flint and other stones." It was on the rocky terrace formed by the Shakopee and Jordan formations near St. Peter, but a little south of the town, and thirty rods distant from the flood plain of the Minnesota river. The smaller one was found "two miles further south, just at the foot of the bank, among a lot of boulders of all sizes." It was found in August, 1874.

FIG. 9.

Primitive flour-mill and outlines of the upper millstones.

The phenomena of the mounds that are scattered all over the State cannot be regarded as palæolithic, since they pertain to a period subsequent to the last glacial epoch. The mounds are found indiscriminately at all levels, and in all relations to the drift deposits—even on the latest deposits. Remains that are found embraced within the actual drift, are classed here, according to Mr. James Geikie, as palæolithic. If they are in the gravel or sand along rivers or in the hardpan of the last glacial epoch they accompanied or preceded the last glacial epoch. If they are in the hardpan of the first glacial epoch they have a still older date. Under this grouping neolithic remains are only those of later date than the last glacial epoch.

The Soil of Morrison County.

The immediate river valley is rather sandy, and has reacted against the settlement of the county; but the general level of the country, away from the river, is of a very different character. There is a fine red loam that covers much of the land east of the river, which is of the same nature and date as the loam that is spread over the uplands in much of the southeastern portion of the State, and has given that section of the State a notoriety for ease of culture and fertility of soil, second to none in the United States. This loam in some places is rather coarse. It is, indeed, seldom clayey, as it is in Houston County, and in other places it is wanting, the soil then being a gravelly hardpan, or gravelly clay. The eastern portion of the county is mainly one of plain, or rises and falls in broad undulations, the valleys being occupied by the creeks that generally drain southward, or toward the Mississippi. On the west side of of the river the alluvial plains are wide, and are rather wet now, but they are destined to be drained, which can easily be done, when they will be found to possess some of the best soils in the county. The hardpan that closely underlies these flats sometimes appears in low knolls which have already been taken by settlers, as they rise slightly above the flats and furnish a different forest growth; while back of the flats is a series of drift bluffs furnishing heavy hardwoods, which correspond with the bluffs on the east side of the river. These bluffs introduce a belt of hardpan clay soils, and continue westward, through slight variations, to the Leaf Hills. Throughout this range, and scattered over the intervening surface, are frequent boulders of granite and of northern limestone.

Water Powers.

There is a fine water-power in the Mississippi at Little Falls, and a rocky island in the river makes its improvement more feasible. This was used at one time for milling and manufacturing purposes, but the dams have been swept out by the river, and the buildings themselves are entirely destroyed. The recent completion of the railroad north and south through the county, running on the east side of the river, is destined to hasten the settlement of this interesting county, and to develop more rapidly its great natural resources.

There are flouring mills already established at the following points:

On the Platte river, Sec. 35, Belle Prairie; three runs of stone, for custom work: also has machinery for cutting lumber. This is known as Grevel's mill.

Hill Brothers' mill is at the mouth of the Little Elk river and manufactures flour and lumber. It has two runs of stone. and 12 feet water head.

V.

THE GEOLOGY OF RAMSEY COUNTY.

Situation and Area.

Ramsey county lies east of the Mississippi and embraces St. Pau the Capital of the State. It contains 101,124.62 acres. It is near rectangular, but is indented on the south by a great northward ben in the Missippi river. On this bend St. Paul is situated. The fo lowing tabulated statistics show the areas of the different town and dates of survey. The territory here described as lying south the Mississippi river was detached from Dakota county and add to Ramsey county by an act of the Legislatnre, approved, Marc 9th, 1874. The county has Hennepin and Anoka on the west, an Anoka on the north. Washington county, about eighteen mil wide separates it from Lake St. Croix, which is the eastern boun dary of the state; separating it from Wisconsin:

SURVEYING STATISTICS OF RAMSEY COUNTY,

By F. E. Snow.

Township.	Range.	Township Lines.		Subdivisions.	Acres.	Remarks.
		When Surveyed.		When Surveyed.		
28	22	S. & E.	September, 1847	October, 1847	7,785.31	North of Miss. River, Sections 24, 25, 35 and 36 lie in Washington County
28	22	N. & W.	October, 1847			
28	22	S. & W.	July, 1853	September, 1853	2,475.62	South of Miss. River. Includes Sections 4, 5, 6, 7, 8 and 9, except the S. W. ¼ of S. E. ¼ of Section 7
29	22	N. E. S. & W.	October, 1847	November, 1847	22,467.09	
30	22	S. E. & W.	October, 1847	December, 1847	19,270.98	
30	22	N	August, 1847			
28	23	N. \ E.	October, 1847	October, 1847	8,158.17	North of Mississippi River
28	23	E. & S	July, 1853	August, 1853	168.37	South of Mississippi River, Section 12
29	23	N. E. W. & S.	October, 1847	November, 1847	18,917.87	Sections 6, 7, 18, 19, 30 and 31 of this township lie in Hennepin County
30	23	S. E. & W.	October, 1847	December, 1847	21,881.21	
30	23	N.	August, 1847			
Total area of Ramsey County					101,124.62	

The Surface Features.

With unimportant exceptions the northern third portion of the county is flat while the remainder is rolling or hilly. becoming more and more broken toward the Mississippi river. Thus rolling surface in the southern portion is due to the present *pose* of the drift materials, and not to any upheaval in the rocks. The rocks everywhere lie practically horizontal, but they have been eroded by streams in numerous instances, prior to the drift-epoch, so that there are deep valleys in the rocky surface. These valleys materially modified the manner of deposition of the drift, and determined its composition at special points. The drift materials seem to have been accompanied by more water, in the act of deposit in the level, northern portion, than in the southern, and have also, since their deposit, been smoothed off by the same agency, during the prevalences of a second glacial epoch. The loam that is spread over the most of the county is the sole product, in the most of Ramsey county, of this second glacial epoch, but it was spread by water instead of ice. Where the old drift clay is visible in the northern part of the county it appears as gravelly ridges rising slightly above the flat country round about, and is then but very slightly covered with the loess loam. This loam, however, is conspicuous and abundant over the most of the county, particularly in the eastern portions.

The Mound View Hills, in Mound View township, afford the most important instance of the prevalence of the old hardpan drift above the general flatness of the country in that part of the county. They are in Secs. 10 and 15, T. 30 N. R. 23 W. They rise about 100 feet abruptly above the valleys which separate them, and about 200 feet above Rice creek valley. They consist outwardly of red gravelly hardpan, but they probably have a nucleus of harder rock. Their remoteness from the main belt of the Trenton makes it less likely that their rocky nucleus is of that formation. The Potsdam sandstone, as a quartzyte, rises in monoclinal hills in other parts of the State round the areas of the St. Peter, and forms several such rocky knobs. In this case, if this quartzyte be the cause of these hills, the original rocky knobs served as gathering places for a greater abundance of morainic drift. For further illustrations of similar phenomena in Minnesota the reader is referred to the Second Annual Report p. 193. This series of knolls does not extend far in any direction, their principal elongation being N. and S. There are three principal hills. They are scantily timbered with Burr Oak. The lands about have comparatively but few Burr Oaks.

Natural Drainage.

The most of the county is drained southwardly into the Mississippi. But the streams are small, and expand into lakes at frequent intervals. In the northern part of the county, where the most of these lakes are situated, there is less diversity of surface, and sometimes the streams, and the lakes themselves, are skirted by extensive marshes or "hay meadows." In the northwestern part of the county the natural drainage is toward the northwest, and reaches the Mississppi through Rice creek. The Mississippi river, which runs along the southern boundary of the county, lies in a deep valley which is about two hundred feet below the general upland. The streams which enter it generally pass down this descent gradually at points several miles distant from the river itself. But above Fort Snelling the streams enter it abruptly, by plunging over the perpendicular bluffs of rock, by wbich the river is everywhere enclosed.

The lakes of the county are, some of them, large and deep, and contain pure and clear water. They have low shores, and are but little below the general level in the northern part of the county, but in the southern they are in deep basins in the general surface, having gravelly shores and frequently attractive natural surroundings. White Bear Lake in the northeastern part of the county, and Lake Como, near St. Paul, are the chief of these lakes that serve as summer resorts; though there are several other large, and perhaps equally pleasant, in the central part of the county. Some of these lakes are united by the St. Paul water works, and supply the city of St. Paul, through Lake Phalen, with water for public and domestic purposes. This line of water works, by means mainly of artificial connections, takes its supply from Pleasant Lake, passes through Vadnais Lake (connecting here also with the waters of Bass, Lambert's and Goose lakes), enters Gervais Lake, then Spoon Lake and finally discharges from Phalen Lake through an acqueduct, into St. Paul. Thus an artificial water-course is established from the northern to the southern boundary of the county—Rice lake, the most distant with evident connection, being on the northern boundary, partly within Anoka county.

The water that issues at Fountain Cave, St. Paul, is that of a creek which disappears in the ground about half a mile distant—toward the city.

The knolls themselves are evidently "kames," and in studying their cause all the problems of the glacial epoch are brought before the mind. They are now supposed to have been formed, so far as the drift is concerned, in the beds of streams of water running on and through the ice, and in openings like great crevasses formed by the underlying rocky knobs, as the ice-sheet passed over them. These hills are conspicuous objects in the horizon from distant points in all directions. They are visible from the high land in Reserve township, Sec. 16, T. 28 N. R. 3 W., and from their summits can be seen Anoka, Hamline University, the Reform School, the spires and smokes of Minneapolis, some of the buildings of St. Paul, and the village of Centerville. This view is more extensive, but not so interesting as that on the peninsula on Sec. 16, Reserve, from which point these hills can be seen, and a fine view can be had over the valleys of the Minnesota and Mississippi covering Fort Snelling and Minneapolis at nearer range.

There is another cluster of lower clayey and gravelly ridges in the northwestern part of White Bear Township, and an outlying area of Upper Trenton, causing a high tract in the southern part of the same township.

The southern part of the county, mainly occupied with the Trenton formation, is generally higher than the northern. The drainage courses which pass through it toward the Mississippi lie in deep valleys, which are surrounded and hid by hills and ridges of drift. These hills probably are due primarily to a rock-sculpture, older than the drift, but the drift is so thick that the rock seldom appears in exposure above the surface. There is some appearance of the former extension of the valley of Rice Creek much further southward, and it is no unreasonable suggestion that the great Mississippi itself may have once occupied this valley, entering the great gorge again where it becomes remarkably widened at St. Paul; but the evidence is entirely topographical. Such as it is, it is perhaps over-balanced by a confusion of hills and high drift-ridges north of St. Paul, which render it improbable that the Trenton is anywhere entirely cut through from the Rice Creek valley to St. Paul, as would have been the case if the Mississippi ever passed through there. Other evidences of this hypothetical position of the Mississippi north of St. Paul are mentioned under the head of Drift.

Description of the Towns of Ramsey County.

T. 28 N. R. 22 W. (*Fractional*) *S. part of* McLean *and part of* St. Paul.

This town shows the extremes between high rolling or hilly land and low alluvial flood plain. The bluff portion east of the Mississippi is about a mile and a half wide and three miles long, running north and south, and is cut by east and west valleys and by tributary creeks, so as to have a rough or hilly surface. It is considerably more than half covered with small timber (oaks and aspens.) The rest of this town east of the river is low, and largely occupied by hay meadows or by marsh. A belt of soft timber growing to large dimensions, separates it from the river channel. On the west side of the river there is a repetition of these features, but in reverse order. W. St. Paul is embraced in this portion. Area in Ramsey County 10,260.93 acres.

T. 29 N. R. 22 W. New Canada, *with N. part of* McLean *and N. E. part of* St. Paul.

This town has a rolling or hilly surface, and is about half covered with timber. Toward the north it is more flat. Through the central portion passes the canal of the St. Paul Water Works and Phalen's Creek. It has several large lakes and also several marshes, but the most of the town is arable agricultural land. Area, 22,467.09 acres.

T. 30 N. 22 W. White Bear.

This town is mainly flat, and embraces a greater water area than any in the county. It also has several large marshes in the northern and central portions. It has a small area of more elevated land in the northwestern corner, east of Pleasant Lake, and another in the southwestern, south of White Bear Lake. The subsoil is a gravelly clay, which sometimes rises to form also the soil, but the surface soil is usually either a sandy loam, which sometimes becomes too light for good farming, or is a clay with a flat surface. Area, 19,270.98 acres.

T. 28 N. 23 W. (*Fractional.*) Reserve, *and W. part of* St. Paul.

This town has a rolling and generally a gravelly clay surface, and is either timbered with small oaks and aspens, or is of rolling prairie. It is diversified on three sides by the bluffs of the Mississippi. It contains no lakes and but few marshes. Area, 8,326.54 acres.

T. 29 N., 23 W. (*Fractional.*) Rose, *and N. W. part of* St. Paul.

The southern part of this town is high and rolling, with a red clay subsoil. The northern part is more sandy and flat, embracing the portion round Lake Josephine and the southern part of Big Bass Lake. It also contains Lake Como, with a number of other minor lakes, with several marshes. These are mainly in the northern portion. Sections 16, 17, 21 and 22 are mainly of prairie. The rest of the town is well timbered. Area, 18,917.87 acres.

T. 30 N., 23 W. Mound View.

The hills already described, near the center of this town, give it its name. Aside from these hills and a tract along the S. W. corner, the whole town is flat or gently undulating, and has a rather sandy soil. This sand, however, is closely underlain by an impervious clay, as evinced by the numerous lakes and marshes which are found within its limits. Rice Creek is a slow, crooked stream, frequently skirted with marshes or hay meadows. The town is somewhat more than half covered with small oaks, with aspens and elms in the low grounds. Area, 21,881.12 acres.

Elevations in Ramsey County.

	Above the Ocean.
Lowest known water in the Miss. R. at St. Paul	676 feet.
Highest known water in the Miss. R. at St. Paul	697 feet.
Summit between White Bear Lake and St. Paul (8 feet cut), according to the St. Paul and Duluth R. R.	959 feet.
Junction at White Bear Lake, St. Paul and Duluth R. R.	920 feet.
St. Paul and Pacific Depot, St. Paul	689 feet.
Base of the Capitol, St. Paul	782 feet.
Bluffs back of the Capitol, head of Robert street	901 feet.
Summit avenue bluff	910 feet.
Junction of the St, Paul and Pacific and the St. Paul, Stillwater and Taylor's Falls R. R.'s	762 feet.
Crossing of the St. Paul and Duluth and St. Paul, Stillwater and Taylor's Falls R. R.s	
Grade of St. Paul and Duluth R. R.	817 feet.
Grade of St. P., S. & T. F. R. R.	797 feet.
Grade of the Mil. & St. P. R. R. at Dayton's Bluff	696 feet.

Soil and Timber.

The southern half of the county has a clayey subsoil, with a clayey lœss-loam overspread; and in general the northern, more flat, portions have the same subsoil, with a sandy lœss-loam over-

spread. There are, however, many spots where the lœss-loam is thin or wanting, where the subsoil constitutes also the soil; but in the southern rolling portions this circumstance is likely to afford a clayey soil, while in the northern this clay is more gravelly. Along the Mississippi River is a large area of alluvial land, which is so wet that it cannot be depended on for general farming, but furnishes a great deal of wild hay. There are also some higher flats along the river that are very fine for farming. The county, however, is not generally occupied for farming, but is owned by non-residents.

The following species of trees and shrubs were noted in the examination of the county.

Quercus coccinea. *Wang.* Var. tinctoria. *Bartram.*

[NOTE.—This is the tree that has been named *Quercus rubra L.* with doubt, in former reports. It is what is known oftenest as "Black Oak," but also is called "Quercitron," and "Yellow Barked Oak." Careful observations were made in the survey of this county on this oak. There was a specially favorable opportunity in West St. Paul, where were seen evidently two species, of oak, the black and the red, yet nearly alike, growing in a ravine in the same situation. This was near the "Farmer's Hotel" on the E. side of the street. They were here in company with white oak. The two species here growing under the same circumstances showed constant differences. Several trees here, of each, are of about the same size, but small. The general habit and color of the two are the same, except that the red is more open-branched, and looser in the top, having fewer dead twigs and branches. The chief distinctions are in the leaf and fruit. The red-oak leaf has the same general shape, and the same number of toothed lobes as the black, but the central undivided portion is wider than in the black, and the whole leaf is longer in proportion to its full width; hence its foliage is coarser and heavier than in the black. The leaves of the red droop, while those of the black turn easily with the wind, and stand in all positions. In the fruit, the acorn of the red is double the size of that of the black, both growing on last year's wood; the acorn of the red rising three or more times the hight of the shallow cup, while that of the black only rises about twice the hight of the cup. The cup of the red is generally an inch across; that of the black about half an inch or a little more.

This is by far the most abundant oak in the county, as it is throughout the southern half of the State; but there are some situations, particularly exposed, high hillsides, like the tops of Mound View Hills, in which it is noticed to fail, though growing abundantly

on lower levels, and to be replaced by the Bur Oak. It does not frequently appear as a large tree, but is generally less than ten inches in diameter, or simply has the size of shrubs, intermixed with Bur Oaks of the same size.]

Quercus rubra. *L.* Red oak.

[NOTE.—At present this oak must be restricted to the only point at which it has been identified, *viz.* West St. Paul.

Quercus macrocarpa. *Michx.* Bur Oak.
Quercus alba. *L.* White Oak.
Ulmus Americana. *L.* (Pl. Clayt.) Willd. American Elm.
Populus tremuloides. *Michx.* Aspen.
Populus grandidentata. *Michx.* Great-toothed Poplar.
Populus monilifera, *Ait.* Cottonwood.
Tilia Americana. *L.* Bass.
Negundo aceroides. *Mœnch.* Box Alder.
Juglans cinerea. *L.* Butternut.
Carya amara. *Nutt.* Bitternut.
Fraxinus Americana. *L.* White Ash.
Fraxinus sambucifolia. *Lam.* Black Ash.
Acer rubrum. *L.* Red Maple.
Acer saccharinum. *Wang.* Sugar Maple.
Betula alba. *Var.* populifolia. *Spach.* (?) White Birch.

[NOTE.—About some of the lakes becomes 12 and 14 in. in diameter.]

Larix Americana. *Michx.* Tamarack.
Juniperus Virginiana. *L.* Red Cedar.

[NOTE.—Large trees grow at Lake Johannah, and also along the rocky bluffs of the Mississippi.]

Salix nigra. *Marshall.* (?) (And other willows).
Ulmus fulva. *Michx.* Slippery Elm.
Prunus serotina. *Ehr.* Black Cherry.
Pinus Strobus. *L.* White Pine.

[Only along the banks of the Mississippi above Fort Snelling.]

Betula excelsa, *of American authors.* Gray Birch.

[At Lake Johannah.]

Prunus Pennsylvanica. *L.* Small Red Cherry.
Prunus Americana, *Marsh.* Wild Plum.
Zanthoxylum Americanum. *Mill.* Prickly Ash.

Ostrya Virginica. *Willd.* Ironwood.
Carpinus Americana. *Michx.* Water Beech.
Prunus Virginiana. *L.* Choke Cherry.
Amelanchier Canadensis. *Torr and Gray.* Juneberry.
Pyrus coronaria. *L.* American Crab Apple.
Rubus occidentalis. *L.* Black-Cap Raspberry.
Rubus strigosus. *Michx.* Red Raspberry.
Rubus villosus. *Ait.* High Blackberry.
Ribes Cynosbati. *L.* Wild Gooseberry.
Ribes rotundifolium. *Michx.* Smooth Wild Gooseberry.
Ribes lacustre. *Poir.* (?) Swamp Gooseberry.

[Has a smooth fruit in racemes.]

Sambucus Canadenses. *L.* Elderberry.
Spiræa opulifolia. *L.* Ninebark.
Spiræa salicifolia. *L.* Meadowsweet.
Celtis occidentalis. *L.* Hackberry.
Alnus incana. *Willd.* Speckled Alder.
Alnus serrulata. *Ait.* Smooth Alder.

[NOTE.—Both alders are found, often in company, on the flats about White Bear Lake, but the smooth rarely exceeds three feet in hight, the other being ten or fifteen.]

Amorpha canesceus. *Nutt* Lead Plant.
Amorpha fruticoso. *L.* False Indigo.

[This has very much the appearance of a small locust.]

Aristolochia Sipho. *L'Her.* (?) Pipe Vine.
Rhus glabra. *L.* Smooth Sumac.
Rhus typhina. *L.* Staghorn Sumac.
Rhus Toxicodendron. *L.* Poison Ivy. (Tuttle Lake.)
Vitis cordifolia. *Michx.* Frost Grape.
Symphoricarpus occidentalis. *R. Br.* Wolfberry.
Corylus Americana. *Walt.* Hazel.
Cornus florida. *L.* Flowering Dogwood.
Cornus sericea. *L.* Silky Cornel.
Cornus alternifolia. *L.* Alternate-leaved Cornel.
Cornus paniculata. *L'Her.* Panicled Cornel.
Ceanothus Americanus. *L.* Jersey Tea.
Vaccinium corymbosum. *L.* *Var.* amœnum. Swamp Blueberry.
Lonicera parviflora. *Lam.* Small Honeysuckle.
Celastrus scandens. *L.* Bittersweet.
Ampelopsis quinquefolia. *Michx.* Virginia Creeper.
Rosa blanda. *Ait.* Early Wild Rose.
Viburnum Opulus. *L.* Highbush Cranberry.
Cornus stolonifera. *Michx.* Red-osier Dogwood.
Cratægus coccinea. *L.* Thornapple.

There is but little heavy timber in the county; yet it is nearly all covered with small trees and shrubs. The uplands and the flat parts of the county are furnished with black and bur oaks and poplar. The rest of the above species of trees are found in exceptional situations, as along the shores of lakes or streams, or in the flood plain of the Mississippi river. Several species are also peculiar to the rocky bluffs.

THE GEOLOGICAL STRUCTURE.

The formations that will here be described, embraced within the county, are as follows:

1. The St. Peter Sandstone.
2. The Lower Trenton Limestone.
3. The Green Shales.
4. The Upper Trenton.
5. The Drift.
6. The Loess Loam.

The St. Peter Sandstone underlies the northern flat and sandy portion of the county and the alluvial portions along the Mississippi, outcropping in the bluffs.

The Lower Trenton is that quarried at St. Paul, and its area is not distinctly separable from that of the other three members of the Trenton. These, taken together, underlie the hilly and clayey parts round St. Paul and extend in diverging arms, one toward the northeast and one towards the northwest. Between these arms, which embrace all three parts, is an area which includes the northwestern parts of New Canada and the northeastern parts of Rose townships, that is probably underlain only by the Lower Trenton. All of these members underlie the township of Rose in general, and the eastern part of New Canada. They would also be found in the high portions of the eastern part of McLean. The key to this distribution is found at St. Paul, and in the hills south of White Bear Lake, where certain features of the topography are found to coincide with their presence, and another set of topographical features to prevail in their absence. These topographical indications are almost the sole guide in thus assigning the parts of the Trenton to different parts of the county, on account of the abundant drift with which the county is covered.

The St. Peter Sandstone.

This sandstone is seen in the bluffs of the Mississippi from Fort Snelling to the southeastern corner of the county; and by reason of the breaking down of the overlying Trenton wherever former drainage streams have run, and the easy erosion of this rock, it also becomes the surface rock in a number of tributary valleys. In the city of St. Paul there is a large expansion of the St. Peter area over the low level through which Phalen's creek, and others, enter the Mississippi, which extends more than a mile north of the river. Further south are several such re-entrant areas in McLean township. The wide bottom-land east of the river, in McLean township, is represented on the geological map of the county, as St. Peter, but it is possible that the Shakopee limestone, which is shown at Red Rock, some further south, extends as the surface rock within Ramsey county, under the alluvium of the floodplain, but it is nowhere visible. At the most it can occupy but a small area. The St. Peter is about 150 feet thick. It has no noteworthy variations of character, as far as seen in Ramsey county, and it has already been described so many times that its lithological features need not be delineated again.

The Lower Trenton.

This is what Dr. Owen styled "St. Peter's Limestone," in his final report on the Geology of Wisconsin, Iowa and Minnesota, and which Dr. B. F. Shumard divided into:—

1. Upper Shell limestone.	F. 3. c........................	6 ft.
2. Non-fossiliferous Bed.	F. 3. b........................	5 ft.
3. Lower Shell limestone.	F. 3. a.............	23 ft.

In later reports, particularly those of the Wisconsin geologists, they were designated as the "Buff Limestone," and the "Blue Limestone," the former lying below the latter. These terms, however were strictly applicable only to formations in Wisconsin, but by inference were extended to cover the geological horizon at St. Paul and the Falls of St. Anthony. The Blue Limestone, however, of northern Wisconsin seems to have been regarded by Dr. Lapham as the equivalent of the Hudson River Group, of New York, and also of a formation of the same name in Ohio, where the term originated, and supposed to lie entirely above the proper Trenton.* These

* When this term was originally applied to the Ohio rocks they were regarded as a continuation of the Trenton limestone of New York.

terms seem still the more inapplicable to the limestones seen at St. Paul and St. Anthony Falls, since the terms "buff" and "blue" should be in reverse order. The "Lower Shell limestone" is more frequently blue than the Upper Shell limestone, and is always so on fresh quarrying. The latter is rather a dirty gray or drab, appearing somewhat like a fine-grained sandstone, and is often harsh to the touch.

Later still the whole of the limestone exposed at St. Paul was classed by Prof. James Hall as the equivalent of the Wisconsin "Buff Limestone," the "blue limestone" being some higher member not distinctly recognized in Central Minnesota, but in the light of further observations now known to be what has been designated by this survey as the "Upper Trenton," at its chief exposures in the southern part of the state, but which has not until the present been discovered as far north as St. Paul. At the same time (Geology of Wisconsin, Vol. I, p. 33.—1862.) Prof. Hall regards the Buff Limestone as the equivalent of the New York "Birdseye" and "Black River" limestone. In the meantime, the "Blue Limestone" in Ohio has become enlarged into the "Cincinnati Group," and the Trenton in that state involved so closely with it that its identity is nearly or wholly lost. On the west of the Mississippi, however, the Trenton has been shown to have a full development, and even to take on a peculiar phase designated "Galena," while the aluminous phase so largely developed at Cincinnati has only been recognized in the "Maquoketa Shales" of Dr. White.

Still more recently Prof. Chamberlain, of the Wisconsin survey, has shown (Geology of Wisconsin, Vol. II, 1873-77) that the lithological differences commonly relied on to distinguish the "blue" from the "buff" are not general nor reliable; that there is no chemical distinction which holds good, and that the fossils of the "buff," as heretofore limited, are also to be found above the "blue." Hence he regards them as essentially one. Further, in the northern part of the State he states that even the *Cincinnati Shales and Limestones* are undistinguishable by any satisfactory line of demarkation from the Trenton limestone, and includes that with the rest, under the general term "Trenton Group."

With these preliminary remarks it will be understood that the term *Lower Trenton* is not supposed to convey any greater significance than an appropriate designation for a local lithological phase, by which the lower part of the great Trenton Group is easily distinguished from the rest in the state of Minnesota.

Wherever the base of the Trenton has been seen in Minnesota, it has been found to consist of about 25 feet of calcareous firm

beds (sometimes with some shaly layers), which give great prominence to this geological horizon in the topographical effects which they produce. They are underlain by an erosible sandrock, and overlain by a varying thickness of green shale. The underlying sandrock crumbles away, letting the limerock project, but the overlying shale sheds the surface waters that would otherwise disintegrate the limerock. These combine to preserve the limerock and to cause it to project in long, prominent headlands, and to form the brows of ridges and terraces which diversify several counties in the southeastern part of the state. The thickness of the overlying shale has heretofore not been supposed to exceed twenty feet, but observations made in Ramsey county go to show that the whole upper Trenton, so called in the southern part of the state, is here changed to a calcareous shale, with thin limestone layers, perfectly comparable to the Cincinnati shales and limestone of Ohio.

In Ramsey county this lower Trenton, or "Buff" limestone, as Dr. Owen at first designated it, is separable into three parts which have pretty constant characters, and they are approximately as given above from Dr. Shumard.

1. Impure, harsh, drab or dirty buff limestone, containing lumps of calcite and species of *Strophomena* and *Orthis*, with other fossils..	6–10 feet.
2. Shale, and calcareous shale with fragments of fossils.....	6–10 feet.
3. Limestone, with aluminous partings. This is the building stone of St. Paul. The mingling of shaly and calcareous parts throughout this limestone causes the dressed surfaces of large slabs to have a blotched or mottled surface, particularly when the dressed side coincides with the natural bedding. This member is the most persistent of the Lower Trenton, but splits into thin layers on long exposure, due to the loosening of the shale throughout the mass. This contains fossils characteristic of the Trenton, but generally in fragmentary condition...............	15 feet.

Besides the three main parts above described there are also several thin beds of green shale in No. 1, which seem not to be confined to any definite horizon, and nearly always a layer of green shale below No. 3.

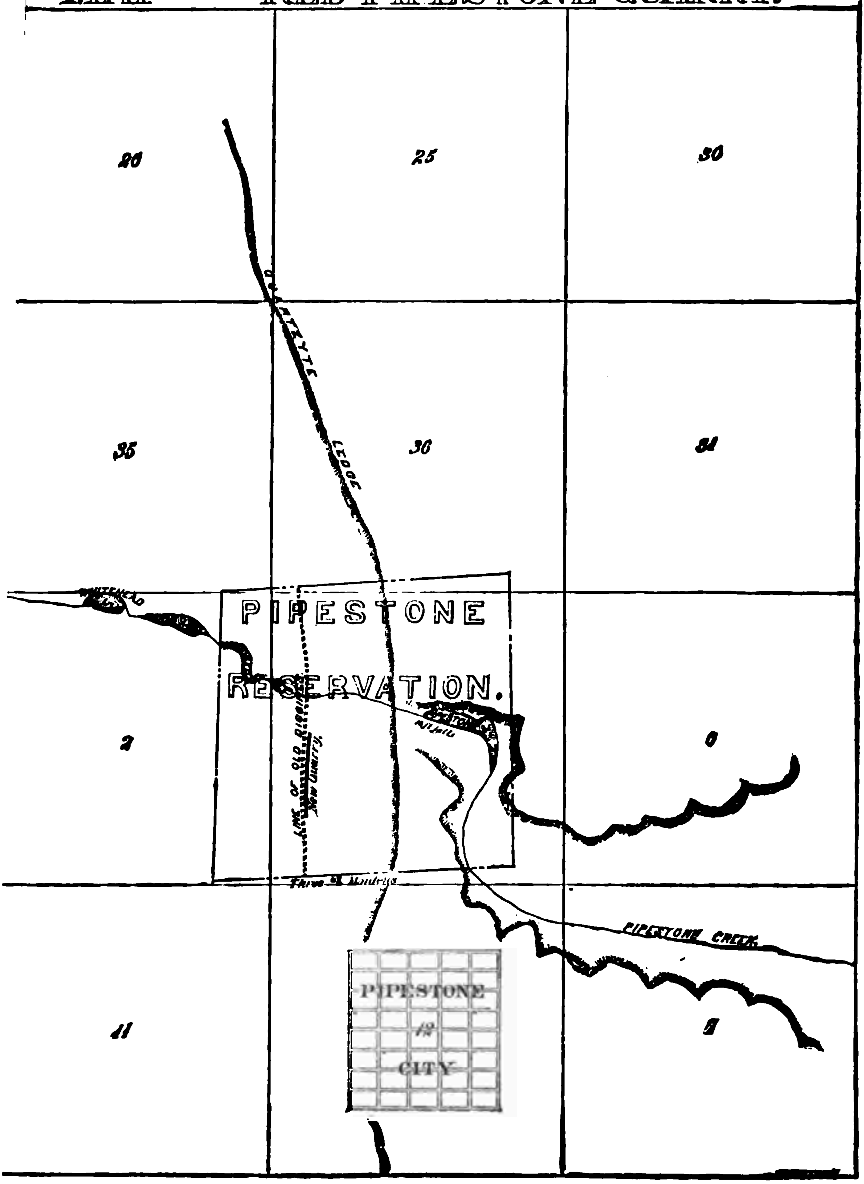
In sections of the bluffs at St. Paul given in Dr. Owen's final report, this limestone is represented as greatly broken and even faulted along the river from Fort Snelling to St. Paul and especially in the vicinity of New Cave (now known as Fountain Cave) near the railroad bridge of the Milwaukee and St. Paul R. R. This locality was specially examined. The layers of the limerock are, it is true, disturbed along the immediate river bluff and are mixed in some

confusion with coarse drift, but at points further from the river the beds continue along horizontal and unbroken, so that the formation itself cannot be said to be disturbed. Dr. Owen attributes rightly this broken condition, so far as the blocks seem to lie on drift materials, to the action of water, and probably that of the river at some higher stage. The beds were undermined and dislodged, but were not transported. Probably floating masses of ice, during the last glacial epoch which did not extend as a continuous ice-sheet east of this place, in Minnesota, played an important part in displacing these limestone blocks, and in depositing among them the water-worn drift.

The Green Shales and Upper Trenton.

The first intimation of the existence of any rock *in situ* in Ramsey county, above the Green Shales as they have been described in counties further south, and in Hennepin county, was found in the drilling of the well at the State Reform School near St. Paul. This was ordered by the legislature of 1877, and was done by C. E. Whelpley of Minneapolis. Mr. F. McCormick, Secretary of the State Reform School, has furnished the following:

MAP OF THE RED PIPESTONE QUARRY.



braced in the term Hudson River Group, which had before been applied to a mass of shales that are now known to be much lower. On account of this error the term Cincinnati Group has been generally substituted.

On the other hand in Iowa and southern Wisconsin and Minnesota, the Trenton limestone is found to pass into the Galena by slow stages and to be followed, at least in Iowa, by a greatly reduced representative of the Cincinnati Group, named by Dr. White the Maquoketa shales. Leaving Iowa and passing into Minnesota the Trenton limestone increases in thickness, and the Galena diminishes, the latter becoming interstratified with beds of shale. In Olmsted county, still further north, the Trenton also contains numerous beds of shale and the Galena is still further reduced. The beds are traceable by continuous or frequent outcrops throughout Goodhue and Rice counties, with an increasing amount of contained shale in the Trenton, and finally with the total loss of the Galena. On account of the soft and shaly nature of the upper beds, by the time they reach Ramsey county they are so covered with the greater drift accumulations that their presence so far north had not before been suspected. Here is an ascertained horizontal change in the character of the beds of this formation, between the southern and central portions of Minnesota, which brings up the question as to the designation they should bear at St. Paul. They are the horizontal equivalents of what has been recognized as the Trenton formation in the southern part of the State, and in neighboring States, and contain the same fossils; but they have the lithological character and the geological position of another well organized group of rocks in Ohio and northern Wisconsin. The eastern Cincinnati fossils are also the western Trenton fossils. Here we have two equally well established names for the same series of beds.

The cause of this gradual change in the formation from dolomitic limestone to a pure limestone, and then to an argillaceous limestone, and at last to a mass of calcareous shales, is to be sought for in the character of the ocean's bed, and the nature of the water and its currents, in the Silurian ocean. And here it is only necessary to apply a well known law of ocean sedimentation, viz.: *the nearer the shore the shallower the water, and the coarser the sediment.* This seems to make dolomitic limestones in the deepest waters, ordinary limestone in deep water, and shales and sandstones in shoal water. The strike of the formation under consideration passes through all these conditions and directly toward the metamorphic area of the State which lies but little further north. Hence, at St. Paul the water was much shallower than at Rochester, and the sedimentation was much coarser; while at Rochester there was much more shaly sediment than at Dubuque. The direction of the strike of these rocks in New York State is along the shore-line of the ancient ocean, and hence the opportunity for noting this change was much less favorable. In Wisconsin and Minnesota the strike is north and south, and in Minnesota rapidly approaches the ancient shore-line.

The Drift.

While the county is wholly covered with a red hardpan clay, believed to be of the age of the first glacial epoch, it shows some variations that require special mention, and is also furnished with a lake deposit which forms the surface soil.

At St. Paul the red hardpan is found uniformly in excavating for buildings in all that low area about the levee, and in the deep cuts through the gravelly bluff north of E. Third street. Although here it is covered with sometimes more than forty feet of lighter-colored drift materials, it emerges from under these immediately on getting outside the valley either north or south, and is covered, but sometimes thinly, with the loess loam. This overlying loose drift is found along the Mississippi valley throughout the county, and everywhere shows the action of water in its deposit. It very seldom contains any clay, and when it does the clay is stony and has a different color from the red hardpan clay. Above Fort Snelling, and in the western part of Reserve and Rose townships, the red hardpan has not the same clayey and unmodified character that it has in the eastern part of the county. It seems to have been washed by water, and in that manner to have lost some of its clay, while there are localities where materials of a different color, particularly gravelly deposits, are superimposed or mixed with it, so that sections seen along the western part of University Avenue have a confused arrangement and mingling of the coarse water-worn materials of both the red hardpan and the gray, with occasional patches of gray hardpan. This water-washed condition also prevails in the low gravelly knolls and ridges that are seen occasionally in the northern flat part of the county, but without any intermixture of materials referable to the gray hardpan. In the high and rolling tract occupied by the Upper Trenton, this red hardpan shows to the best advantage, whether in the western or eastern part of the county. In the deep excavations made in St. Paul this red hardpan is seen to be overlain by a fine red laminated clay, which is probably of the same nature and origin as the so-called *Tripoli* found at Stillwater, the thickness of which sometimes reaches six or eight feet, but which in some places is entirely wanting. This seems to be related to the underlying hardpan sheet somewhat as the laminated brick clays and loams of later date are to the gray hardpan which they overlie, and was deposited during the waning period of the former glacial epoch, and when water was abundant but comparatively quiet.

What has now been described, *i. e.* the red hardpan and the red laminated clay overlying it, were the products of a glacial epoch which brought its materials from the north and northeast, the red color being due to the prevalence of the debris of red sandstone, shale, and other iron-charged rocks that are developed largely in the vicinity of Lake Superior. Whether this ice-period preceded or followed the excavation of the immense gorge of the Mississippi which is visible southward from Dayton's Bluff in St. Paul, is not ascertained by any observed facts, but several considerations would require a date subsequent to that excavation—or to the greater portion of it. It is probable the Mississippi began to excavate that gorge at the time of the elevation that brought the upper Trenton (or the Cincinnati) above the Silurian ocean, an event which has been taken to divide the Silurian in America into two parts, the upper and the lower. In that case it is the oldest portion of the Mississippi gorge at present known, and has since that event carried off the waters of the Metamorphic land areas of Wisconsin and Minnesota. The St. Croix valley seems to be equally old, and perhaps served for the drainage mainly of the Wisconsin area, while this carried only the waters of the Minnesota area, the two uniting then, as now, at or near Hastings. The sculpturing of the rocks into canyons in the western portion of Wisconsin, and their uniform trend southwestwardly show they must always have reached either the ocean or a great river, lying in that direction. Isolated areas of the Trenton in northwestern Wisconsin, as well as in central Minnesota, left to the present without destruction, though surrounded by larger areas of older formations deeply cut by the same forces into gorges and wide valleys, point directly to the close of the Lower Silurian as the starting point of the history of this part of the Mississippi valley. The rest of the valley-gorge, even to the Gulf of Mexico, being composed of much later formations, must have been unformed, even buried in the slowly accumulating sediments of the ocean for many ages later. If some portions of it are wider, or deeper, than this, it is due to greater volume of water, and to softer rocks, not to greater age. It is probable, then, that the advent of the first glacial period did not divert the Mississippi river from its channel below St. Paul. But the valley is much narrower above St. Paul than it is below, and this continues indefinitely southwestwardly by way of the Minnesota valley. This is very noticeable on examining the geological map accompanying this report. There is also a significant change in the direction, and one the more significant as it seems not to have been due to any rock formation existing at St. Paul, but directly

contrary to the rock sculpturing that exists there favorable to the continuance of the river in any preoccupied valley running in the same direction. Allusion has been made to a possible ancient gorge through the Trenton north of St. Paul in describing the surface features of the county, but in the geological map of the county no such gorge is represented, because it never has actually been discovered, and its hypothetical location would perhaps be of no service.

These anomalous and significant facts can all be reasonably explained on the supposition that the Mississippi river was diverted from its ancient valley-gorge, north of St. Paul by the ice and drift of the first glacial epoch, and that it was driven into that which has been described in the report on Hennepin county, toward the west further, and joined the Minnesota valley at some point above Fort Snelling, but between that point and Shakopee, without passing over or through the Trenton limestone at all. Their united waters then formed the river which excavated the gorge between Fort Snelling and St. Paul (unless the Minnesota alone had already done it) between the first and second glacial epochs.

When the second glacial epoch came on, the country must have been more or less covered with constant or periodical ice sheets for many miles south of the line limiting actual glacier movement. These minor local and seasonal ice-areas produced their subordinate effects, but so similar to those of the great moving glacier itself that it is rendered very difficult, except with the aid of certain marked differences in the nature of the transported material, or some fortunate topographical or other evidence, to define the area of the second great glacier as compared with that of the first. These local ice-areas, which could not have had much movement as ice, served to disturb the surface of the old drift, and, by the water they afforded on breaking up periodically, to carry away the clayey parts, and to mix superficially the materials of the new drift with the old. At points, like that of Hennepin and Ramsey counties, where a great river course co-operates to mix these materials, we would necessarily see the new extending farthest over the old, and even the effects of ice in large masses extending down the valleys further than on the uplands.

In Hennepin county, and generally over the northwestern part of the State, are evidences that the ice of the second glacial epoch moved rather from the northwest than from the northeast. (See Hennepin county report, 1876.) The washed surface of the old drift, and the area of the loess-loam, both indicate that Ramsey county and the southeastern part of Hennepin were not disturbed

generally by the glacial ice of this epoch. The disturbance, however, was sufficient to choke up again the Mississippi river, and at the mouth of Bassett's creek in Minneapolis, to drive it to the east, as fully detailed in the report on Hennepin county, thus bringing it into the channel that it now occupies between Bassett's creek and Fort Snelling.

The drift of the second glacial epoch is found as a stony clay in few places in Ramsey county. In some of the excavations at St. Paul, in the lower portions of the city, a gray hardpan is found, and there may be a considerable of it even under the water of the river itself, filling a deep gorge, but it lies over the red hardpan when that also is present. The disintegration and wash from the shales of the Upper Trenton seems also to have mixed with the drift at St. Paul so abundantly as to produce a stony gray clay which is hardly distinguishable from the true glacial clay. Some parts of Reserve township also show patches of the gray hardpan, rather mixed with than overlying the red.

As a gravel or course sand, the product of the second glacial epoch is much more abundant in Ramsey county. The gray gravel and sand, with the washed limestone pieces and boulders composing the bluffs and hills that have been so much excavated for streets at St. Paul, are the modified product of the second glacial epoch, modified at the time of their origin and deposition by the water resulting from the disintegrating margin of the glacier (perhaps here feebly extended to this point) but augmented by the co-operation of the natural waters of the Mississippi, then swollen to great dimensions. The same deposit, but much less abundant, produced by the same agency (except the presence of the Mississippi) is spread over much of Reserve or Rose townships, and has already been alluded to as the indirect effect of the second glacial epoch over the pre-existing drift surfaces.

Occasional pieces of northern limestone are found in the drift ridges and knolls about Mudhole and Fitzhugh and Gervais lakes, and two pieces of native copper were found on the south side of White Bear lake, near the Ramsey county line. Indistinct glacial marks in West St. Paul, under the red hardpan, run W. N. W.; but this was an unsatisfactory observation.

The Loess Loam.

That this deposit is the result of widespread diffusion of fresh water, at the time of the last glacial epoch, over those surfaces either drift-covered or not, which were not at the time affected by

the glacier movement, is highly probable; but what the peculiar circumstances and causes of such gentle diffusion of nearly tranquil waters were, it is not yet possible satisfactorily to detail. The loess loam is found in all parts of Ramsey county, but it varies in thickness and in composition. It is thin or wholly wanting in some rolling gravelly tracts, and is very thick in some confined valleys. It is sandy, or graduates downward into sand, in much of the northern part of the county, particularly in Rice Creek valley, and in some places in the bluffs of the Mississippi below St. Paul, and it is fine and somewhat clayey in the high and rolling clay tract in the eastern part of the county, particularly in the eastern part of New Canada. It forms a very fine soil for farm crops. It covers the boulders and gravelly clay of the real drift. It fills some old valleys —indeed is always thicker in valleys than on the uplands. It is occasionally stratified and passes into sand below in places where agitated water was abundant enough to have moved such materials before the epoch of the loam. In other cases it is placed abruptly immediately over a coarse, gravelly or boulder-bearing stratum.

In the southwestern corner of the state (Rock and Pipestone counties) there is a gradual change from stony boulder-clay to the loess loam, horizontally, in passing from the Coteau de Prairie (in Lyon and Murray counties) southward to the Iowa state line. Exposures along the banks of creeks, and the digging of wells, make this plain. There is a gradual loss of boulders, then of the small stones, then of gravel; and an equally gradual increase of the characteristic features of the loess-loam,—close, clayey consistency, crumbling in the air like slacking quicklime, and white limy concretions. In some cases the concretions, which have been so often mentioned as a peculiarity of the loess-loam, are in the same deposit with small gravel stones of northern origin; and pieces of northern limestone. The drift clay, true northern boulder clay, the product of glaciers, thus changes gradually into a true loess-loam, the product of aqueous agencies. While this indicates for that locality, at least, a merging of one force into the other, and the slowness of the change, through an interval of about 50 miles in a broad, level, open country, it perhaps gives the key to the events that occurred in other latitudes where the surface was more broken, and where the effects are more complicated by not having all the steps recorded. Just as in the older geological formations, wherever the series is complete, without sudden transitions, the history is best known, so in the history of the drift, where the effects change gradually, are the records of "lost" epochs, and these "beds of transition" need the closest scrutiny, being the only evidence of what transpired

between formations which in other regions pass abruptly from one to the other. This here indicates that the age of the loess-loam was cotemporary with that of the boulder clay in the Coteau de Prairie. There must be some explanation given for the co-existence of these forces which spread the loam and those which brought the glacial drift. In other words, if the loam, which is sometimes a laminated clay, be regarded as the equivalent in age of the fine laminated clays of the great lakes and of other high-water marks in the northwest, which have been referred to a distinct "epoch" by Dana and others (the Champlain), then that epoch was not subsequent in time to the glacial epoch but cotemporary with it, and its phenomena differ from those of the last glacial epoch because they have been studied at distant points where they are contrasted, and where the glacial winter operated differently. Where there is an immediate succession of superposition, that fact in the drift does not imply immediate succession in time any more than it does in the Silurian rocks, a fact which has been ignored many times; and hence have resulted a great many special histories and theories. The loess-loam, for instance, lies on the older drift clay all along the Mississippi valley, and has generally been taken to prove an immediate transition from the drift-epoch to the loam-epoch, when really a long period of time, involving forest growths and the slow on-coming of a glacial epoch, intervened, the loam itself passing horizontally into the glacial deposits of that epoch.

So in Ramsey county the loam has been seen to follow by insensible gradations from a sand or even a fine gravel, the change here taking place perpendicularly. In this case the coarser deposit below was the result of more copious and more agitated water, as in the bluff-terraces below St. Paul, or in the washed materials in the western part of Reserve township, and the loam the result of the diminution and more quiet state of the same waters. Thus, if the waters which overspread and washed the old drift and formed the gravelly terraces of the Mississippi came from the ice-fields of a contemporary glacier lying further north. then the waters which spread the loam, a finer deposit, also came from the same source, operating a little later, and with diminished force.

Wells in Ramsey County.

Good water for all household purposes is obtained in Ramsey county with little effort, in shallow wells that seldom pass through the drift, the majority of them being less than twenty-five feet deep. Throughout the northern portion of the county water is generally

found in sand, or below a sandy loam, which also rises to the surface forming the soil and subsoil. The underlying clay is seldom penetrated to any great depth. But in the southern portion wells more frequently are deeper, and obtain water in gravel after passing through not only the surface loam but also a greater or less amount of red clay.

Material Resources—Timber.

The county is generally clothed with a scant forest growth, but the trees are small. There is not much timber of any sort suitable for lumber, and it is not much cut for fuel. Farmers cut some and haul it to St. Paul, but the wood fuel of St. Paul is very largely supplied from the "Big Woods," west of the Mississippi river.

The county has generally a good soil, the most of which still lies in its primeval condition. So far as the natural resources of the county are concerned, they lie in its soil to a greater extent than in any thing else.

Building Stone.

The stratum of the Lower Trenton used at St. Paul is the same as at Minneapolis, and furnishes a stone similar in all respects. The stone for the piers of the bridge over the Mississippi was taken out in West St. Paul, but about half a mile above the bridge.

The quarries in West St. Paul are in the public street, and are worked by Adam Rowe.

On the other side of the river, Mr. Sigler has quarries in operation on Stewart Avenue, near Leech street. The most important quarries in St. Paul are near the State Capitol, but there are a great many other small openings in different parts of the city.

Although this formation has been used in the majority of the stone buildings in St. Paul, and makes a fine appearance, yet its tendency to disintegrate has caused it to be less regarded, and has led to the introduction of other building stone. The U. S. Custom House is built of Sauk Rapids granite, and the Baptist Church of the Shakopee limestone quarried at Kasota.

Along the south side of White Bear lake, Sec. 32, Grant, Washington county, are exposures of the Trenton, some of which have been opened by Messrs. Walter and Weaver. Another is on the land of Mr. Huffman on Sec. 30, nearer the lake, in the bluffs facing northeast; and still others are further south and east. There is every reason for expecting as good building stone here as at St. Paul, except that the beds would naturally be a little more shaly,

being situated nearer the ancient shore line when the deposit was forming, and for the same reason that makes the Trenton at St. Paul more shaly than at Faribault. These exposures, however, have not been much worked, and do not seem to be generally known.

Mills and Water-Powers.

The *St. Paul Mills*, St. Paul, are owned by Henry Shaber, and are on Phalen's creek. They have three run of stone for flour and one for feed. Have 20 feet fall of water, and turbine wheel. Only grind for custom use.

The *Brainerd Mills*, (Thau and Ham), have three runs for flour and one for feed, and are also in Phalen's creek, with 30 feet fall and turbine; custom and shipping.

The *City Mills*, (Lownsman, owner) St. Paul, have two runs of stone for flour, and 19 feet fall; custom only.

The *North Star Mills* are also at St. Paul, and have three runs of stone for custom work, and 19 feet fall, owned by Protz and Braun.

The *Union Mills* are owned by W. Lindeke, with four run of stone, and 20 feet fall, situated at St. Paul.

The last three above are run by overshot water-wheels.

The *Reserve Mill* are on the Fort Snelling road, at St. Paul, and are only calculated for grinding feed; have two runs of stone and 20 or 21 feet fall; owned by — Cunrad. These mills used to do flouring.

Brick in Ramsey County.

John Jæger, St. Paul, on Dayton's bluff, makes red brick from the loess loam.

Graham & Co., W. St. Paul, make red brick from clay taken from the alluvium of the flood plain. This yard, however, is now inactive, and is owned by John Jæger.

Section 32, White Bear. Formerly a good red brick was manufactured at a point between the railroad and the lake shore (Vadnais lake), from the surface loam that here covers the country, but as the owners were not much patronized, owing to the general financial depression which retarded all building, the yard was closed, and remains so.

The brick clay which is seen in the bluffs at St. Paul, in the excavations made for street purposes on Fifth street, between Sibley and Wacouta, lies between deposits of coarse gravel and stones, all water-washed. This clay, which is probably the near equivalent in age and nature of the brick clay so extensively used for brick at Minneapolis and Carver, has not been thus employed at St. Paul.

Earthworks.

On Dayton's Bluff are several large mounds, one being about six feet high and 30 or 40 feet across.

At White Bear Lake is a large artificial mound, about 12 feet high and 35 or 40 feet across. It is close to the shore of the lake, within the village, on lot 2, on the road to Goose Lake.

In Dayton's bluff, on P. Kelly's place, is a covered cave in the white sandstone, not far from Carver's cave, in which is a deposit of clay containing lumps, and some large pieces, of what goes by the local name of "kaolin." It is purely white, tasteless, and gritless, and seems to be the same as the white veinings found in the lacustrine clay of the Red river valley. This clay is said to completely fill the cave, which was discovered in digging to make room for a house and barn in the lower part of the bluff. The clay resembles that seen at Mankato in the nooks of the Shakopee rocks, as described in the Second Annual Report, but it has not been possible to give it, nor the cave, any satisfactory examination. It is probably of the nature of Carver's cave itself; and they should both be carefully examined for traces of ancient habitation.

In another part of the Annual Report for 1877 will be found further account of early man in Ramsey county, and illustrations of some implements found in St. Paul.

The survey of Ramsey county was facilitated by the active interest and guidance of Hon. C. S. Bryant, of St. Paul.

VI.

THE GEOLOGY OF ROCK AND PIPESTONE COUNTIES.

Situation and Area.

These counties form a rectangle running north and south, in the very southwestern corner of the State, and border on Iowa and Dakota. They have a width of a little more than three government towns, and each a length of four.

Surveying Statistics of Rock County.

BY F. E. SNOW.

Township.	Range.	TOWNSHIP LINES.		SUBDIVISIONS.	Acres.
		When Surveyed.		When Surveyed.	
101	44	S............	August..........1852	September..1869	23,035.46
...	..	N. E. W.......	July, August....1867	....	....
102	44	N. E. S. W	July, August....1867	September..1869	22,929.55
103	44	N. E. S. W	July, August....1867	September..1869	23,078.93
104	44	N.............	September......1858	October......1869	23,081.10
...	..	S. E. W.......	July, August....1867	....	....
101	45	S.............	July............1852	November...1869	22,948.32
...	..	W............	September......1858	....	....
...	..	N. E..........	July, August. ..1867	....	....
102	45	W............	September......1858	November...1869	22,941.68
...	..	N. E. S........	July, August....1867	....	....
103	45	W............	September......1858	October....1870	22,997.45
...	..	N. E. S........	July, August....1867	....	....
104	45	W. N..........	September......1858	October.... 1870	22,974.94
...	..	E. S..........	July, August....1867	....	....
101	46	S............	July............1852	September...1870	23,048.40
...	..	E.............	September......1858	....	....
...	..	N. W..........	September......1867	....	....
102	46	E.............	September......1858	September. .1870	23,072.24
...	..	N. W. S........	September......1867	....	....
103	46	E.............	September......1858	Sept., Oct...1870	23,038.05
...	..	N. W. S........	September......1867	....	....
104	46	E.............	September......1858	July.........1871	23,100.92
...	..	N.............	September......1861	....	....
...	..	S. W..........	September......1867	....	....
101	47	S.............	July............1852	September...1870	7,928.52
...	..	W............	July............1859	....	....
...	..	N. E..........	September......1867	....	....
102	47	W............	July............1859	September...1870	7,889.56
...	..	N. E. S........	September......1867	....	....
103	47	W............	July............1859	September...1870	7,862.81
...	..	N. E. S........	September......1867	....	....
104	47	W............	July............1859	July.........1871	7,788,18
...	..	N.............	September......1861	....	....
...	..	E. S..........	September......1867	....	....
			Total	number of acres	307,716.11

Surveying Statistics of Pipestone County.

BY F. E. SNOW.

Township.	Range.	TOWNSHIP LINES.		SUBDIVISION.	Acres.
		When Surveyed.		When Surveyed.	
105	44	S.	September......1858	August......1867	23,006.06
...	..	N. E. W	July, August....1861	...	...
106	44	N. E. S. W	July, August....1861	August......1867	23,064.09
107	44	N. E. S. W	July, August... 1861	Aug., Sept...1867	22,998.97
108	44	N	September......1858	September...1867	22,885.66
...	..	E. S. W	July, August....1861	...	...
105	45	S. W	September......1858	September...1867	23,434.99
...	..	N. E	July, August....1861	...	...
106	45	W	September......1858	September...1870	23,451.93
...	..	N. E. S	July, August....1861	...	...
107	45	W	September......1858	September...1870	23,527.78
...	..	N. E. S.	July, August....1861	...	...
108	45	N. W	September......1858	July.........1871	23,468.29
...	..	E. S.	July, August ...1861	...	...
105	46	E.	September......1858	July.........1871	23,048.16
...	..	S.	September. 1861	...	...
...	..	N.	September......1870	...	...
...	..	W.	July............1871	...	...
106	46	E.	September......1858	Sept., Oct...1870	23,001.83
...	..	N. W. S.	September......1870	...	...
107	46	E.	September......1858	October.....1870	23,044.78
...	..	N. W. S.	September......1870	...	...
108	46	E.	September......1858	July.........1871	22,959.70
...	..	N	September......1861	...	...
...	..	S.	September......1870	...	...
...	..	W.	July............1871	...	...
105	47	W.	July............1859	July.........1871	4,852.06
...	..	S.	September......1861	...	...
...	..	N.	September......1870	...	...
...	..	E.	July............1871	...	...
106	47	W.	July............1859	October.....1870	4,783.90
...	..	N. E. S.	September......1870	...	...
107	47	W.	July............1859	October.....1870	4,771.48
...	..	N. E. S.	September......1870	...	...
108	47	W.	July............1859	July.........1871	4,588.07
...	..	N.	September......1861	...	...
...	..	S.	September......1870	...	...
...	..	E.	July............1871	...	...
			Total	number of acres	296,887.75

Natural Drainage.

The drainage is toward the south and southwest, and finally enters the Missouri river near Sioux City, in Iowa, being the only water from the State of Minnesota that takes that route to the Gulf of Mexico. The main stream is Rock river, which flows almost due south, receiving several tributaries from the east, but none that are important from the west. Other streams rise west of Rock river, having their headwaters near that stream, but flow westward, leaving the State, and finally reaching Big Sioux river. These latter are the Flandrau, Pipestone, Splitrock and Beaver creeks.

These streams are all small, and in the summer time some are rather valleys where gathers a little water, than living streams. They furnish no water-powers that have been improved, as yet, though without doubt, some parts of Rock river would furnish sufficient fall for milling by a little artificial aid.

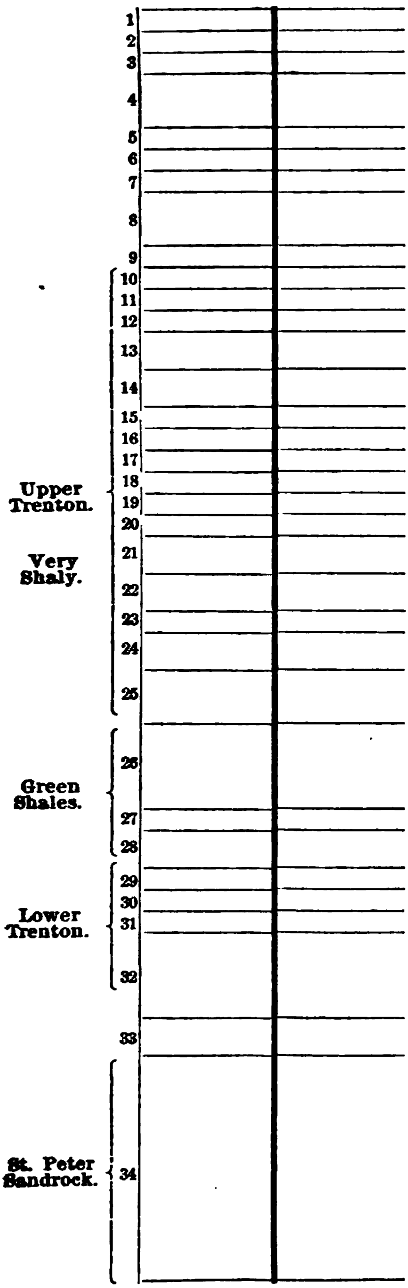
Surface Features.

These are emphatically prairie counties, and are nearly level over large tracts. They are undulating in their eastern portions, due to the existence of more numerous streams whose valleys lie rather deeply below the general level. Along the valley of Rock river and its tributaries is the greatest diversity seen in these counties, and this is mainly confined to Rock county, though the high peninsula between Rock river and Chanaranbie creek in the southeastern part of Pipestone is a prominent object in the horizon for many miles.

Rock river valley is about a mile or a mile and a half wide. The immediate banks are from six to ten feet above the water, and are composed of gravel, which is sometimes coarse, and is very largely made up of limestone. The outer banks are from fifty to seventy-five feet higher, and on the eastern side are more stony with foreign boulders than on the west, a circumstance, however, which may be owing to the action of the prevailing western winds, which would uncover and keep bare the coarser materials of the surface by blowing away the sand and clay during the dry and windy months of the year, while the bluffs on the west side would not only not receive such winds, but would serve to collect all particles flying toward the east from the prairie above.

The range of high rocky land running northwest from Mound, near Lu Verne, is a conspicuous object in the horizon from the north and east, and looks like the Coteau from Marshall. The highest point is where it breaks off squarely to the valley of Rock river, and

Notes of the Deep Well Bored at the State Reform School, in the Months of April and May, 1877.



	Feet.
1. Two feet black soil..............	2
2. Three feet gravel................	3
3. Six inches clay..................	0½
4. Thirteen feet coarse gravel.....	13
5. One foot fine sand	1
6. One foot coarse gravel	1
7. One foot fine sand....	1
8. Thirteen feet coarse sand......	13
9. Two feet boulders.....	2
10. Three inches lime rock.........	0¼
11. Three feet clay..................	3
12. Two feet sand, with water......	2
13. Six feet three inches shell rock with clay.....................	6¼
14. Seven feet hard lime rock......	7
15. Two feet clay........	2
16. One foot hard rock..............	1
17. Four feet blue clay..............	4
18. Four feet hard rock.............	4
19. One foot blue clay..............	1
20. Three feet lime rock............	3
21. Six feet clay, light color........	6
22. Five feet clay, dark color......	5
23. Four feet yellow clay...........	4
24. Five feet blue clay..............	5
25. Eight feet blue clay (very hard).	8
26. Twenty-eight feet blue clay....	28
27. One foot limestone (hard)......	1
28. Six feet blue soap stone........	6
29. Three feet lime rock............	3
30. Three and one-half feet blue soap stone.........	3½
31. One and one-half feet lime rock	1½
32. Twenty-eight and one-half feet blue lime stone................	28½
33. Five feet blue clay..............	5
34. Seventy-seven and one-half feet white sand rock...............	77½
Whole depth..................	252

An abundant supply of water was obtained at the depth of 150 feet. This supply, however, was not tested until after the well had been bored one hundred feet below it. The drill at that point, became fixed and immovable, so that the contractor was wholly unable to proceed further, when, after experimenting with pumps, it was found that the supply was sufficient for all practical purposes.

The water was obtained after drilling about ten feet in the lime rock of No. 32.

From this source the water rose in the well about eighty feet. The water is supposed to be of excellent quality.

Of these, No. 34 is plainly the St. Peter sandstone. No. 33 is the green shale which is nearly always seen over the sandstone in Hennepin and Ramsey counties. Nos. 32 to 29, inclusive, include the Lower Trenton, but the thickness seems greater than elsewhere observed, being 36½ feet. The rest of the drill seems to be taken up with alternating shale and limestone layers, the greater portion being of shale. Of this thickness (101½ feet) probably the main mass of shale, near the bottom, said to have been 28½ feet thick, represents the green shales that had before been identified; but there is not sufficient difference between this and the rest to exclude the application of the same term to the whole of the beds above No. 29.

A few months later an exposure of green shale was seen in the road, N.W. ¼ Sec. 9, in Reserve, accompanied by *Chæteets* and *Orthis*, above the level at which the regular green shale could exist. Blocks of fossiliferous blue limestone were also seen abundantly along a ravine in the same township, (Sec. 15) mixed with the debris of the red hardpan clay, far above the level of the Lower Trenton; a circumstance at variance with any thing before seen in Ramsey county. Finally, the beds in place were found in a good exposure along Ramsey street in St. Paul, where it ascends St. Anthony Hill. They were first seen in a little artificial ravine made for a watering tank. They are exposed in a similar manner in other ravines that descend St. Anthony Hill toward the river, farther west. The basis rock of St. Anthony Hill is the same. Their thickness above the Lower Trenton is 108 feet, and they have a conspicuous strike, as already stated, in a line of drift-covered bluffs that run from St. Paul northwestwardly, reaching Anoka county south of Rice creek, causing the high and hilly land there seen. These beds also form the nucleus of the high land that extends from St. Anthony Hill southwestwardly toward Fort Snelling, distant about three-fourths of a mile from the river.

These beds are very shaly, not more than one-third of the whole being limerock, and contain the usual fossils of the Lower Trenton, but their paleontology has not yet been examined carefully. The whole formation seems to have the characters of the Cincinnati, as exposed in Green Bay, Wisconsin, or in Ohio.

The Trenton Group.

In New York the Trenton limestone is succeeded by a mass of shales with the local designations, Utica slate, Frankfort slate, Shales and sandstones of Pulaski, and Lorraine shales. These were all em-

is distinctively known as "The Mound." There is no rock south or east of that, except occasional boulders, which are common along the drift bluffs of Kanaranza creek.

The country northeast from Lu Verne, along the Champepedan creek, and toward the "Lost Timber" (Sec. 2. T. 105, R. 43 W.) is in general, a fine undulating prairie, the subsoil being a yellowish, gravelly and stony clay, with rarely a visible boulder.

The bluffs of Chanaranbie creek and Rock river, in Pipestone county, are abrupt and from 75 to 100 feet high, composed of drift. There are here a great many short, sharp ravines, branching from these valleys, cut deeply, like the ravines in the bad lands of Montana. The flat bottom lands support a heavy growth of grass.

Beaver creek valley is broad, with changing rolling bluffs, about half a mile wide, with no terraces. The low land is cultivable, but little water being in the valley. The upland is also undulating or rolling, a prairie, with no shrubs nor trees, nor stones. The soil is the loam, which becomes more and more like the loess loam of the Missouri, toward the south, while toward the north it is more gravelly and stony. Along Beaver creek the stones are very scarce, but they do occur along the brows of knolls, and are struck in digging wells, even in this loam.

Pipestone county is more uniformly a smooth prairie than Rock, and is marked by long ridges or swells, corresponding to the low water-sheds running north and south. The subsoil of this county is nearly everywhere a gravelly or stony clay, but becomes finer toward the surface, and in the soil it is rare to see a northern boulder.

There are but few settlers in Pipestone county, and Rock county has but lately been occupied. Pipestone city is a "paper town" and has three houses, one of which is occupied and accommodates the only post-office in the county; but it is on the line of the probable extension of the Southern Minnesota railroad. Land in both counties is rapidly being taken both by settlement and purchase, the new-settlers being generally farmers from the eastern part of Minnesota or from further east.

THE GEOLOGICAL STRUCTURE.

The only known bedded rock in these counties is a red quartzyte, probably the equivalent of the New York *Potsdam Sandstone*, but which Dr. C. A. White, of the Iowa survey, has designated the *Sioux Quartzyte*, as it is seen to outcrop in the extreme northwestern corner of Iowa. Of this the largest exposures are in Rock county, but the best known is at the famous "Pipstone Quarry," near the center of Pipestone county.

As this locality has become somewhat famous on account of the extensive use made of the red pipestone by the Indians, and the difference of opinion expressed by scientists as to its origin and age, the following *resumé* will be of interest:

The first written account of the quarry was by George Catlin, found in the 38th volume of the First Series of the American Journal of Science and Arts, p. 138, in a letter addressed to Dr. C. T. Jackson, to whom he also sent a sample of the pipestone for analysis. The journey was made on horseback from the falls of St. Anthony, in the summer of 1836, in company with "a young gentleman from England, of fine taste and education," and a single Indian guide. Mr. Catlin describes the quarry as "on the very top" of the Coteau des Prairies which rises above the country about it with graceful and almost imperceptible swells. The quartzyte he regards "a secondary or sedimentary deposit," but no further defines its supposed age.

Jean N. Nicollet visited the quarry in July 1838, as is plainly shown by his own name and date for that year, together with the initials of his companions, boldly and artistically cut on the quartzyte, at the top of the ledge, near the "Leaping Rock," and a little north of where the creek passes over the brow of the escarpment. His "Report, intended to illustrate a Map of the Hydrographical Basin of the Upper Mississippi river," is "Document 237," of the second session of the 26th Congress, ordered printed Feb., 1841. He gives no opinion of the age of the rock, but quotes Dr. Jackson's analysis of the pipestone, or *Catlinite*, as it was named by Jackson. "As a mineralogical species it may be described as follows: compact; structure slaty; receiving a dull polish; having a red streak; color blood red, with dots of a fainter shade of the same color; fracture rough: sectile; feel somewhat greasy; hardness not yielding to the nail; not scratched by selenite, but easily by calcreous spar; specific gravity 2.90. The acids have no action upon it; before the blowpipe it is infusible *per se*, but with borax gives a green glass." While Prof. Jackson assimilates it to *agalmatolite* (*pinite* of Dana) Nicollet regarded it as differing very materially from it in general aspect, its conduct before the blowpipe, and its total insolubility in sulphuric acid.

Prof. James Hall, next in chronological order, read a paper before the *American Philosophical Society* in June, 1866, in which, among notes on the geology of some of the western portions of Minnesota, he classes the red quartzite as Huronian. He imagines the Coteau des Prairies caused by a vast synclinal in the rocks of this age. He did not see the pipestone quarry itself, having only gone to Lake

Shetek, where he describes a wall of rock which he thinks the same in age. His examinations were made in 1865. His is the first attempt to fix the age of this rock.

Dr. F. V. Hayden visited and examined the locality in October, 1866, and his account is in the *American Journal of Science and Arts* for January, 1867. After examining rock of the same kind on the James and Vermilion rivers, in Dakota, and at Sioux Falls, on the Big Sioux river, he gives an interesting detailed description of the quarry, and inclines to the opinion that the quartzyte is supra-carboniferous, Triassic perhaps, or an extension downward of Cretaceous No. 1.

Dr. C. A. White has given a description of a "Trip to the Great Red Pipestone Quarry," in the *American Naturalist* for 1868–9, but he does not there state anything concerning the age of these rocks, though elsewhere, he has ranked them as pre-Silurian, and named the formation the "Sioux Quartzyte." (Geology of Iowa, 1870).

The reader is further referred to the first and second Annual Reports for reasons for believing this formation to be the equivalent of the Potsdam sandstone of New York.

The known area of this rock in Rock and Pipestone counties is approximately marked out on the accompanying map, but there is much probability of its being much greater, and perhaps to include the greater portion of both counties. The Cretaceous formation, no doubt, also occurs in the northern part of Pipestone county, and overlies unconformably the quartzyte in other places, but it has not been seen. Dr. Hayden has mentioned such facts in his account of the geology of southwestern Dakota, occurring at or near the mouth of Firesteel creek, on the James river.

At the Red Pipestone quarry there is a ledge of rock which runs north and south nearly three miles. This ledge of rock consists of layers of red quartzyte that have a dip of fifteen or twenty degrees toward the east, so that the rock soon disappears under the prairie in that direction, but presents a nearly perpendicular escarpment toward the west, formed by the broken off heavy layers of the rock; though its greatest hight, which is not more than 25 feet, is a little north of the present pipestone quarry. It also gradually disappears under the prairie both toward the north and toward the south, the lower ground on the west of the escarpment slowly rising, in those directions like the sides of a basin, and coalescing with that on the east of the ledge. A small stream, dry some parts of the year, known as Pipestone creek works northwestwardly and passes over the ledge from the upper prairie to the lower with a perpendicular fall of about 18 feet. In the vicinity of this fall, and also at one or

two places further south, are dwarfed bur-oaks and shrubs, but the country in all directions for many miles is a prairie which has a great monotony of surface. It is not on the top of the Coteau de Prairie, as supposed by Catlin, that range of hills being 25 or 30 miles further northeast. Mr. Catlin seems to have correctly described the eastern ascent of the Coteau as rising with almost imperceptible swells above the prairies further east, but failed to observe when he passed down the western slopes, that the real Coteau dies out still more insensibly into the prairies on the western side. The Coteau passes nearly through the middle of Lyon county, the northeastern quarter of Murray, the southwestern part of Cottonwood, and leaves the state along the western side of the DesMoines river, in Jackson county, gradually becoming less noticeable. It is characterized by numerous lakes and gravelly drift hills. It is a vast glacial moraine, comparable to the ridges in northwestern Ohio, and the "Kettle Range" in Wisconsin, but is the most remarkable, as it is the most extended, glacial moraine known in the United States if not in the entire world. It runs along the east and north side of the Missouri river till it passes out of the United States into British America.

The little stream which crosses the rock at the pipestone quarry widens out into a lake just before passing the ledge, making Pipestone lake, and again after passing it, it forms Crooked, Duck and Whitehead lakes in the same way. In these lakes water stands constantly.

The rock itself in general is exceedingly hard, in heavy layers of one foot, or of two or three feet, and is separated by jointage planes into huge blocks of angular shapes that lie often somewhat displaced or even thrown over entirely by the action of the frost through many winters. Thus, there is a rough talus along the foot of the escarpment where grow a few bushes and small oaks, protected from the prairie fires by surrounding masses of fallen quartzyte. The rock is sometimes pinkish and massive; when blood-red it is more apt to be thin-bedded.

The real "pipestone quarry" is situated about a quarter of a mile west of this ledge and in the low land of the lower prairie. Earlier diggings seem to have been opened in the superficial outcroping of the pipestone layer, and to have followed along its strike north and south nearly a mile, without penetrating very deeply into the rock. The layer which furnishes the pipestone is about 18 inches thick, and is embraced between heavy layers of the same rock as the ledge already described, and they all dip together toward the east, and of course run under the main escarpment. The present quarrying is

a little east of the line of old diggings, but follows along the strike of the formation the same as the other, the only difference being in having greater depth (the pipestone layer is about 6 feet under the ground here) and in the difficulties encountered in removing about five feet of very firm, pinkish quartzyte in heavy beds.

The Catlinite itself is a fine clay varying in color from blood-red to pale red, or pinkish, or even to a pale yellowish red. The lighter colors fade into the darker, but sometimes the light appears in the red as round spots, on a polished surface, but the red is not thus distributed through the lighter shades. It has, of course, suffered all the metamorphic influences that the quartzyte itself has, but it has not lost its distinctly bedded structure, which may be seen when examined microscopically in polished thin sections. Indeed it seems to have a laminated structure; and the different shades of color appear sometimes to be due to openings and fissures produced in the red clay and becoming filled with sediment of a lighter color. It seems to be made up of little grains of quartz having an abundant cement of red ferric oxide, the alumina present (as indicated by chemical analyses) being mixed rather with the latter than combined with the former.

Prof. Peckham, who has analyzed for the survey samples of the red and of the pale red pipestone, makes the following report:

Prof. N. H. Winchell:

MY DEAR SIR—I have the pleasure to report the following analyses of serial numbers 52 and 53:

No. 52—Pale Catlinite.

Silicic oxide	SiO_2	58.25	per cent.
Aluminum oxide	Al_2O_3	35.90	"
Water	H_2O	6.48	"
Total		100.63	

The aluminum oxide is a trifle too high and contained a trace of iron (Fe_2O_3.) This specimen did not contain an appreciable amount of either lime or magnesia.

No. 53—Red Catlinite.

Silicic oxide	SiO_2	57.43	per cent.
Aluminum oxide	Al_2O_3	25.94	"
Ferric oxide	Fe_2O_3	8.70	"
Water	H_2O	7.44	"
Total		99.51	

This specimen contained in addition a trace of both lime and magnesia.

A comparison of these results with those given in Dana's Mineralogy, ed. 1870, confirms the statement there made that Catlinite is a rock and not a mineral. The substance appears to be an indurated or partially metamorphosed clay containing a variable amount of ferric oxide and water.

An analysis by the late Dr. Jackson, of Boston, (Am. Jour. Sci., I. xxxv., 388) gives the following in 100 grains:

Water	8.40
Silica	48.20
Alumina	28.20
Magnesia	6.00
Per-ox. iron	5.00
Ox. Manganese	.60
Carb. lime	2.60
Loss (probably magnesia)	1.00
Total	100.00

These results indicate a considerable amount of earthy carbonates and when compared with those given above show that the rock is quite variable in composition. Neither of the specimens analyzed by myself was of the spotted or mottled variety, which *may* account for the presence of the earthy carbonates in the analysis by Dr. Jackson.

The red variety was found to be much more difficult to decompose by fusion with alkaline carbonates than the average silicates. It was found necessary not only to reduce it to an impalpable powder but to prolong the fusion to from eight to ten hours to insure complete decomposition.

Respectfully submitted,

S. F. PECKHAM,

MINNEAPOLIS, MINN., May 20, 1878. *State Chemist.*

Southward from the region of the Pipestone quarry the land continues high, and in some instances there are ridges, or long knolls, of drift, that are broad and evenly rounded over by a thin loam. The first exposure of the rock, in the vicinity of the road to Lu Verne, is on Sec. 13, T. 105, R. 46, along the south side of the valley that crosses westwardly near the centre of the section. It extends about a mile east and west. It here is seen to form an undulating floor on which the loam is thinly spread. It is hard, massive, pinkish-colored and superficially vitrified, in some places also showing two directions of glacial striæ, one being by compass nearly N. and S. and the other S. 52 deg. E.

The same line of rocky outcrop extends westwardly to the Split-rock creek, and along that creek and its eastern tributaries as far as it continues in the State. It seems to have a changeable dip, but nowhere presents perpendicular bluffs.

Two and a half miles further south on N. E. ¼ Sec. 36, is another exposure of the same rock, along a similar shallow ravine making westward—and again about half a mile further south on the high prairie.

At a point about ten miles north of Lu Verne this rock becomes frequently exposed both in the valleys and on the hills and continues so to the Mound, near Lu Verne, when it suddenly breaks off along the west side of Rock river, and is not known to the south of that place. Throughout this distance it forms a high plateau three or four miles wide and about a hundred feet higher than the prairies east or west, but the surface, though frequently rocky, is not rough. It is undulating ; and the plateau sinks gradually down tothe level of the rest of the country on either side. This plateau terminates abruptly in a rocky and precipitous bluff facing southeastward, three miles north of Lu Verne in what is known as "The Mound." There is a very large rocky outcrop in Secs. 4, 5, 6, 7 and 8, T. 103 N., R. 45 W. There are less frequent exposures in Gregory township, and the town next west. The Splitrock creek which crosses the northwest corner of Rock county has frequent exposures both in Rock and Pipestone ; but in Pipestone the rock range veers toward the east, into the centre of T. 104. R. 46 W., and disappears till reaching the region of the Pipestone quarry. In the N. W. part of Mound township the rock dips N. W. with a thrown, or twist, which, by slightly changing it, brings it soon below the surface. Indeed there seems to be a succession of ridges or swells, with changeable dip, though the most observable is to the northwest, about 10 degrees. These ridges are not covered with gravel or sand like similar ridges already mentioned east of the Coteau, under the operation of glacial forces, (ice and water) but while they occupy the grand divide of the county, they are nearly bare, on their tops and along their slopes, or are thinly covered with a gravelly loess loam, while the drift, even the stony clay that has been largely attributed to ice, occupies the valleys between to the thickness of at least 30 or 40 feet. On the top of some of these ridges, apparently near the top of this formation, the rock is conglomeritic. This occurs in large superficial areas, planed and smoothed down (rarely glaciated) and the colors of the pebbles, usually not larger than beans, give these spots a blotched and variegated mottling. The pebbles are mainly white, but some are jasper-red and some purple.

All over these ridges, which vary from a quarter of a mile to three or four miles in length, and are for the most part thinly covered with soil and turf, there are little nests of large blocks of quarzyte

piled so together that they seem to have been thrust up from below by some force. The edges of these blocks are squarely broken off, and slope toward each other, *i. e.*, toward the centre of the pile, while the blocks themselves lie so that their upper surfaces slope in all directions away from the center. Similar upheaved spots occur on the red quartzyte outcrop near New Ulm, and were described in the report for 1873. They were then attributed hypothetically to recent igneous forces. These upheaved spots vary from five to fifteen feet in diameter, or perhaps more. They may have been caused by ice, *i. e.*, alternate freezing and thawing with the change of seasons, aided by the force of vegetation and a little soil gradually getting into the openings.

At "The Mound," where this high land terminates abruptly, and faces the valley of Rock river, the elevation is about 175 feet above the river. The perpendicular bluff of rock is from 40 to 60 feet in its highest part; but owing to a dip of about 20 degrees from the horizon, nearly west, or partly northwest, and to the breaking off of the upper layers causing a gradual slope from the brow of the hill backward through several rods, the actual thickness of beds visible may be 150 feet. The rock here also appears to be almost entirely a reddish or pink, heavy-bedded, quartzyte. If wrought there might be some softer and thinner layers discovered in the angles of the talus, but the refractory nature of the great mass of it will cause it to be used but sparsely for building. The main bluff curves westwardly at both ends, and by reason of the dip and ravines that enter the valley from the west, its exposed layers gradually disappear under the soil in that direction, and the rock is lost in the prairie.

Near the base of the bluff of perpendicular rock, on a slope which descends to the river, once probably covered by the water of the river, on some of the lowest beds, the rock has the general shape of glaciation, but there are no striæ, the surface showing rather the action of water. On the top of the bluff are glacial striæ running S. 20 deg. W. by compass. Ten miles northwest of Lu Verne such marks run N. and S.

The Drift.

The most important fact in connection with the drift of these counties is a gradual transition, from north to south, from drift clay, with stones and boulders to loam clay that has all the characters of the well-known loess-loam of the Missouri valley. The northern part of Pipestone county lies not far from the Coteau du Prairie,

which is a vast glacial noraine of drift materials, and is even affected somewhat in its contour by the westward decline of the Coteau to the prairie level. It is as characteristically a hardpan clay—the main mass of the drift, in this part of Pipestone county—as in any part of Minnesota. In traveling southward there is a gradual superficial change in all its characters. This change pervades at first but a small thickness of the deposit but by degrees involves the drift to the depth of 20 feet. At first there is a diminution in the number of visible boulders; then a smoothness in the creek bluffs; then a gravelly clay on the surface, fine and close; then a closeness in the prairie soil; then, in digging wells a few limy concretions are seen mingled with small gravelstones, and at last a fine, crumbling loam clay that cannot be distinguished from the loess loam, which extends to Sioux City in Iowa, and there *is known* as the loess-loam of the Missouri valley and has a thickness of several hundred feet. Wells dug in the southwestern part of Rock county demonstrate also a similar *perpendicular transition from loam to drift clay*, the former being true loess-loam and the latter true hardpan, or boulder clay. This appears like rank heterodoxy, but it is not a matter of opinion nor theory. It is the result of actual observation. The writer was as much surprised to find it as others will be to read it, and it appears almost inexplicable. The writer had abundant and favorable opportunity for observing this change in the grades and cuts of the new railroad from Lu Verne to the State line, and verified it in wells dug, and being dug, in that part of the county. In some places the loam passes below into a quicksand.

We have here then a series of changes by which, between the Coteau and Sioux City the loess-loam is produced from the drift hardpan, by the slow withdrawal of the stones and gravel, and the gradual predominance of water-action over ice-action, the Coteau being the limit of unmodified ice-action involving the whole drift sheet. It is not impossible that ice, in a broad sheet, underlay the surface, embracing the now underlying hardpan, while superficial waters disturbed and modified the surface of the drift for some distance south of the Coteau. Thus it seems that, by the agency of water very largely, a considerable tract of country was covered by drift which differs at first but slightly from the true hardpan, but at points more removed from the field of glacial action, becomes more and more clearly a water-deposit. This change could be observed only in a broad, level tract like southwestern Minnesota. This southward conversion of the stony and gravelly clay into the loess-loam must have been the result of copious drainage and wash from the northern drift, but a wash that seems to have been so gradual,

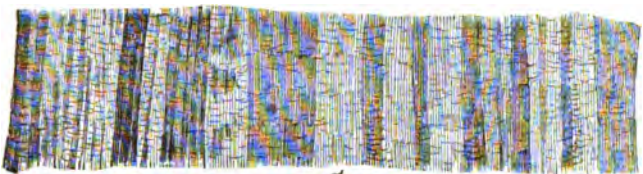
and yet so profound in its effect, as to have embraced at once a great thickness of the drift materials, causing them to flow more like a pasty mud at first, than water, but finally becoming simply a muddy water. This process is perhaps what covered the extensive buried soils and vegetable remains in Fillmore and Mower counties, beyond the limits of the last ice-period, without wholly disrupting them, and perhaps will account for the same phenomenon in Ohio and Illinois. It seems evident that the vast moraines of the northwest, where, in similar topography, the changes witnessed in the drift must be due to changed climatic conditions, mark great epochs in the history of the ice-age. There are two such that cross Minnesota, the older being the Coteau, and the younger the Leaf Hills. Corresponding to the latter the Kettle Range in Wisconsin seems a parallel phenomenon. [See also the report on Ramsey county.]

There is evidence of glacier-action, or what has been recognized as evidence of glacier-action, in Rock county south of the Coteau. The quartzyte is polished, striated, and sculptured superficially on the tops of the ridges in the central part of the county as only glacier-ice is known to do. At the Pipestone quarry, (near "The Three Maidens") such marks run 22 deg. W. of S. by compass. On the strike of the ledge at the same place they ran S. 10 deg. E. varying to 20 deg. W. of S. On Sec. 13, T. 105, R. 46 W. they run in two directions, one direction being nearly N. and S. and the other S. 52 deg. E. within the valley of a little stream. On the rock near the top of the southern side of this valley, which is a slight, shallow depression, glacial marks runs S. 22 deg. W. This is but a few rods from the last observation above. At another point, about ten miles north of Lu Verne, glacial marks were observed running nearly N. and S. On the rock at "The Mound" they run S. 20 deg. W. by compass. It seems almost impossible that in so level and open a country, and on the same rocks, without apparent cause, the glacier which must have been hundreds of miles wide, if it existed here at all, could have taken so diverse directions in so short distances. It cannot be doubted, however, that this marking was done by a force that exerted a great pressure at the same time that the marks were made. This pressure is evinced not only in the marking itself, which is on the hardest formation found in the State, but in the innumerable checks and flaws that cover the surface where this rasping has taken place, and yet leave it in the main a smoothed and rounded or *stossed* surface. These checks run curvingly downward at varying angles with the surface, and to all depths less than an inch, but usually less than one-sixteenth of an inch, and indicate perhaps an incipient crushing to the depth of at least an

inch. They show in what manner the rasping reduced the original projecting knobs. Where the natural seams or planes of jointage cross the rock, these little checks are larger, causing the quartzyte to chip off sooner and deeper with a curving and choncoidal fracture. This prevailing direction is transverse to the crushing force, so that the rock, along some grooves, has a short conchoidally laminated structure transverse to the grooves, penetrating it to the depth of a quarter to half an inch, exhibited now in a series of little curving furrows where the laminæ broke off successively, the concavities of the laminæ being toward the north.

FIG. 10.

N.



S.

Striated red quartzyte in Rock county.

This marking is represented in Fig. 10, but the figure does not show a great many fine checks with which the surface of the rock is nearly covered, but it shows correctly the prevailing direction of the curvature, and its relation to the moving force. This manner of glaciated marking is visible on Sec. 13, T. 105, R. 46, and also on "The Mound," near Lu Verne. It can be compared to a cross-grained planed board, where the plane has been driven against the grain, except that the cut edges are curved so as to present their concavity toward the cutting or planing force.

It has already been mentioned that there are but few boulders in Rock county. They are generally confined to the creek bluffs and valleys. Even on the plateau caused by the red quartzyte running from near Lu Verne northwestward they are not seen, or are so rare as to be noteworthy. This is an anomaly. In ice-covered regions, *i. e.* in regions known to have been last passed over by the ice of the drift epoch, there would be no place where foreign boulders would be found more thickly than on such rocky elevations.

In traveling over the plateau of quartzyte, about on Sec. 16, Mound, one large solitary granite boulder may be met with. It lies directly on the quartzyte. It is rough and granulated, and there is a circular excavation or concavity in the soil in which it lies. It is about ten feet long and five feet high, and has a groove horizon-

tally circumscribing it about a foot in width and three or four inches deep. Taken altogether it immediately reminds the beholder, not less by its general shape than by this groove, of the *stone hammers* sometimes found. Its size precludes its being one, but its shape is very like them. The groove may have been formed by the action of ice and water on its sides, as it has the appearance of lying in ordinary seasons in a little lake of water, which at the time of this examination was entirely dried up. This boulder, like the "Three Maidens," at the Pipestone quarry, must be referred to the date of the boulder clay, and in that case it was not disturbed by, but probably witnessed, the spreading the loam which came later.

The "Three Maidens," and the three others, (smaller) that make up the cluster of six granite boulders lying just outside the Indian Reservation at the Pipestone quarry, also rest on the surface of the red quartzyte about 60 rods southeast of the quarry and at the foot of the long ledge or escarpment that passes north and south. They evidently once constituted one immense boulder and have become six from the falling apart, under the influence of frost, of the granite along its natural seams or joints. Such a separation of large boulders is sometimes seen on the prairies in Minnesota under circumstances which demonstrate their former entirety.

On the surface of the glaciated quartzyte about these boulders, which is kept clean by the rebound of the winds, are a great many hieroglyphic inscriptions, which were made by pecking out the rock with some sharp-pointed instrument. They are of different sizes and dates, the latter being evinced by their manner of crossing and interfering, also by a difference in the weight of the instrument used. They generally represent some animal, such as the turtle, wolf, bear, badger, buffalo, elk, and the human form. The "crane's-foot" is the most common. They are very similar to those represented on Plates XI and XII of Vol. II, of the "Bulletins of the U. S. Geol. and Geog. Sur. of the Territories," accompanying the article of W. H. Holmes on Ancient Ruins in Southwest Colorado. The Indians regard the "Three Maidens," represented by the three larger boulders, as the maids from whom the tribes sprung after the destructive anger of the Manitou had slain the people. It would seem as if any warrior or hunter who had been fortunate in the chase and happened to pass here, left his tribute of thanks to the Great Spirit in a rude representation of his game, and perhaps a figure of himself, on the rocks about these boulders. In some cases there is a connection of several figures by a continuous line, chipped in the surface of the rock in the same manner, as if some

legend or adventure were narrated, but for the most part the figures are isolated. This is the "sacred ground" of the locality. There are hieroglyphics at no other place around here, though there is abundance of bare rock.

Common Wells in Rock County.

The water of wells in the loam, or in the drift-clay, is very hard. This is caused by a large amount of limestone gravel disseminated through all the materials of the drift, derived from the limestones of Winnipeg. There is occasionally a water which has a distinctly alkaline character, but this is not common. Nearly all the wells of the county are curbed with pine boards, and from that fact great numbers of them are contaminated with the organic decay known to result from that practice, and a number were examined that were very foul from that cause. Several recent cases of typhoid fever at Lu Verne are directly referable to that cause, and no doubt, if the facts could be known, many others in the country could be accounted for in the same way. The curbing of wells in the prairie regions with pine boards or planks is very common, owing to the lack of convenient stone, and the ease of constructing such curbs of wood; but it is a practice which all well-diggers should loudly and persistently protest against, and which all the owners of wells should discontinue, as it is a fruitful source of foul water, causing intestinal diseases and typhoid fevers. The adjoined table shows the depth and character of some of the wells of the county.

Wells in Rock County.

Owner's Name.	Location.	Depth—feet.	Remarks.
A. L. Marsh	S. W. ¼ Sec. 4, Lu Verne	33	Only seep water; water hard; "joint clay" all the way, more compact in the bottom.
— Stone	Lu Verne	13(?)	Sandy loam, then loose stones, some large, 6 ft.; gravel 8 in.; pebbly clay 7 ft.; then blue clay.
— Taylor	N.E. ¼ Sec. 10, Lu Verne	84	No water. Loamy sand, with stones; pebbly clay, becoming blue at 24 ft.; blue clay 15 ft.; fine, dry sand; a shell (described like a common fresh water clam) and wood were taken out at 52 feet in this sand, which is clayey when wet, and fine like flour when dry. (This may be the Cretaceous.)
W. O. Crawford	S. E. ¼ Sec. 20, Beaver Creek	28½	Abundant good water in quicksand; in "the lower edge" of the stony blue clay, twenty feet below the surface, a stick with grain like elm was taken out.
— Kennedy	N.W. ¼ Sec. 35, Lu Verne	42	Poor water; a dangerous gas gathers in this well; cedarwood found at 38 feet.
— Taylor	N.E. ¼ Sec. 10, Lu Verne	12	Loam; gravel; "fine dry sand," which sparkles in the sun; this sand is so fine as to be water-tight, and to make a reservoir for water, and may be of the Cretaceous.
Peter Webber	S.W. ¼ Sec 8, Lu Verne	42	At first no water, but afterward filled to within 10 feet of the top with a poor (alkaline) water; "joint clay" all the way, with crystals of gypsum.
Worthington & Sioux Falls R.R.	Sec. 17, Lu Verne	15	"Joint clay"; loose stones and gravel with water; "red clay" below the gravel.
Samuel Spalding	Sec. 20, Lu Verne	28½	"Joint clay or red clay"; then blue clay; water from a sand vein in "joint clay."
— Shively	Kanaranza	22	Good water from sand at 18 feet, under "joint clay."
Henry Halbut	Magnolia	30	Seep water, good; "joint clay" all the way.
E. Sheldon	Beaver Creek	18	This is in the general valley of Beaver Creek, between two ravines; good water; six feet sandy loam; six feet stones and gravel; two feet shells and sand (these shells were Unio and were soft and rotten); two feet blue clay, containing wood.
Lary McDermott	Mound	25	Good water; struck the rock under gravel and sand.
Samuel Spalding	Sec. 20, Lu Verne	10	Good water in gravel.
C. R. Henton	Sec. 22, Beaver Creek	48	Loam; blue clay; good water from sand layer in the blue clay; stone curbing.
W. T. Henton	Sec. 30, Beaver Creek	68	Loam; blue clay; stopped in blue clay; water foul from the wood curbing.
C. Williams	Sec. 28, Beaver Creek	36	Loam; blue clay; water seeps.
Wm. Grout	Sec. 24, Beaver Creek	24	Loam and clay; good water; the clay was all gravelly, except the very surface soil, with little bunches of sand; water seeps.
Lu Verne House	Lu Verne	16	Good water in gravel.

Material Resources.

These counties contain some of the best farming lands in the state. They are not broken by rock exposure (except through the central part of Rock county), so that nearly all their area is tillable. The rocks that underlie them are not known to hold anything of great economical value. They will serve as a building material, but are rather hard even for that, and it may be found more economical to bring in by railroad the building stones of the eastern counties. The main material product of these counties is now, and will always remain, *wheat*, of which they will produce as much to the acre as any county in the State.

VII.

PALÆONTOLOGY.

Notes on the Fossils of the Trenton in Minnesota.

During the month of July, 1877, some time was given to the examination and arrangement of some of the fossils of the Trenton in the collections of the survey, continuing thus the work begun the season before. As but little time could be had for this part of the work of the survey, the results are meager. The fossils represented by the following list are additions to those named in the report of last year. It was found that a greater range of authorities for reference was necessary for the reliable identification of our specimens, and measures have been taken for procuring many foreign and American works, containing descriptions of the fossils of this horizon.

By reference to the Museum Report accompanying this, the corresponding numbers of the Register will be seen, and other particulars of each species ascertained.

No. 90. *Asaphus extans, H.?* (Compare No. 399). This specimen has been in the museum a number of years, and its origin is unknown; but its similarity to specimens obtained of Mr. W. D. Hurlbut, from Trenton Falls, N. Y., renders its source less doubtful. It is probably from the Trenton formation in Minnesota. It has a tuberculated surface instead of a lamellose one, as *A. extans* is described by Hall.

No. 172. This block contains fragments of the crinoid of Hall, *Schizocrinus nodosus*, with an unidentifiable species of *Murchisonia*, and fragments of a trilobite. *Locality*, Pleasant Grove, Olmsted county.

No. 185. Slabs containing *Strophomena*, *Orthis*, *Chætetes*, *et al.* Fillmore county.

No. 186. *Orthis perveta Con.* These are considerably larger than the type specimens. They are from Taylor's quarry near Fountain. Fillmore county.

No. 189. Fragments of *Asaphus gigas, H.* From Fillmore county.

No. 191. Slab with *Leptæna sericea, Sow. Orthis emacerata, H. Strophomena filitexta, H. and Strophomena, nitens, Bill.;* from Fillmore county.

No. 192. *Poteriocrinites caduceus, H. Orthis testudinaria, Dal. Rhynchonella capax, Con.* are also from Fillmore county.

No. 197. This is provisionally named *Othoceras laqueatum, H.* but the agreement is not satisfactory. *Locality*, Spring Valley, Fillmore county. (Compare No. 214.)

No. 208. *Strophomena tenuistriata.(?)* Compare Nos. 204 and 371. *Locality*, Sec. 17, Rochester, Olmsted county.

No. 214. This slab shows *Leptæna sericea, Sow. Murchisonia bicincta, H. Orthoceras laqueatum, H. Bellerophon bilobatus, Sow. Strophomena, nitens, Bill. and Rhynchonella capax, Con. Locality*, Spring Valley, Fillmore county.

No. 242. *Cyrtoceras arcuatum, H.* has been obtained from Holden, Goodhue county.

No. 243. *Oncoceras constrictum, H.* is from the same locality.

No. 252. *Orthoceras vertebrale, H.* is from the same locality.

No. 269. *Orthis subquadrata, H.* has been identified from Sec. 30, Forestville, Fillmore county.

No. 293. *Strophomena fluctuosa, Bill.* is found in the upper layers of Willson's quarry at Mantorville, Dodge county, which is in the Galena.

No. 294. *Graptolithus scalaris, Linne* is found in the same layers.

No. 297. *Discina Pelopea, Bill.* is found in the same layers. Compare No. 263.

No. 307. *Chætetes petropolitanus, Pan. ?* is found on Sec. 21, Forestville.

At Minneapolis have been identified different forms of *Rhynchonella capax, Con.* and of *Orthis perveta, Con.* The following have also been found at Minneapolis: *Orthis emacerata, H. Var. multisecta, James. Chætetes Lycoperdon, H. Murchisonia bicincta, H. Pleurotomaria subconica, H. Schizocrinus nodosus, H. Cyrtolites compressus, Con.* and *Bellerophon bilobatus, Sow.*

No. 348. *Cyrtolites compressus, Con.* occurs on Sec. 16, Pleasant Grove, also *Orthoceras strigatum, H.* (Nos. 350 and 381.)

From Pleasant Grove, Olmsted county, also comes *Oncoceras constrictum, H.* (No. 352).

No. 376. *Asaphus gigas, H.*—from St. Charles, Winona county.

No. 397. *Orthoceras vertebrale. H.*—from St. Charles, Winona county.

No. 392. *Orthis bella-rugosa, Con.*—from St. Charles, Winona county.

No. 399. *Asaphus extans, H. (?)* (Compare No. 90). This specimen was obtained of W. D. Hurlbut, and is from Trenton Falls, N. Y. It differs from Prof. Hall's description of *A. extans* in having a surface rather pustulated than lamellose.

No. 410. *Asaphus gigas, H.* and *Strophomena filitexta, H.*—from St. Charles, Winona county.

VIII.

REPORT ON THE GEOLOGY OF RICE COUNTY.

BY L. B. SPERRY.

Situation and Area.

The northern border of Rice county is about 35 miles south of St. Paul, and its eastern border is about the same distance west of Lake Pepin. It is bounded on the north by portions of Dakota and Scott counties; on the east by Goodhue county; on the south by portions of Steele and Waseca counties, and on the west by Le Sueur county. It is four Government townships, or 24 miles, in width east and west. The western portion of the county is of the same length—24 miles north and south—but the eastern two tiers of townships are shorter by 5 miles.

The county contains 14 townships, each of them, except two, containing 36 square miles. Of these two exceptions, one, Bridgewater, contains 40 square miles, and the other, Northfield, 44 square miles.

Its area then is 330,240 acres, of which nearly one-half is timber land interspersed with many lakes.

There is but very little land in the county unfit for tillage.

That portion east of the Straight and Cannon rivers is the finest of prairie land, while most of that west of these rivers is, or was originally, covered with valuable timber, which, on being removed, leaves a strong and fertile soil.

Fairbault is the county seat. Northfield, Morristown, Dundas and Shieldsville are the principal towns.

Natural Drainage.

The drainage of the county is to the north and east. Straight river enters the county 2½ miles east of the middle of the southern border, and, flowing northward about 8 miles, forms a junction, (where the city of Fairbault now stands) with the Cannon river, which enters the county about 2 miles north of its southeast corner. From the junction of the Straight and Cannon rivers—taking the latter name—the waters flow northward and leave the county 4 miles east of the meridian line upon which the Straight river enters its borders. The western half of the county contains about a score of shallow but pretty lakes, which receive the surface waters of their localities, and empty for the most part by very circuitous routes into the Cannon. The Straight and Cannon also receive the drainage from the eastern portions of the townships through which they flow; while the eastern tier of townships, for the most part, shed their waters through small streams into the Little Cannon and Zumbro rivers in Goodhue county. The Straight river enters the county in the Lower Trenton formation, and cuts through into the St. Peter sandstone 3 miles north of the county line, near Walcott's mill.

A short distance from Walcott's the river makes an extensive bend toward the south, and on reaching Faribault has cut 80 feet into the sandstone.

At a point near the line separating Bridgewater and Cannon City townships the river has cut through the St. Peter sandstone and begins its flow over the Shakopee limestone, into which it has cut about 30 feet when it leaves the northern boundary of the county.

This descent of about 150 feet in crossing the county furnishes at least eleven available mill privileges which have been improved and are in operation.

The following tabular exhibit shows the most important and interesting facts relative to these:

Water Power Mills in Rice County.

Name of Mill.	Owner.	Location.	Stream.	No. of feet fall.	Run of Stone.	Barrels daily.
Walcott	Chaffee & Sheffield	5 miles South of Faribault	Straight R.	....	4	100
Straight River Mills	J. D. Greene & Co.	Faribault	Straight	13	3	60
Kendall	Greene & Gold	Faribault	Straight	7½	4	80
Matteson's	H. M. Matteson	Faribault	Cannon	6	4	80
Polar Star	Stock Co	Faribault	Cannon	8	7	150
Warsaw		Warsaw	Cannon	5	3	50
Hershey's	C. Hershey	Morristown	Cannon	7	2	Custom.
Roberds Lake	J. G. Scott	Outlet Roberds Lake		15	2	50
Cannon City	R. H. Scott	Ne'r Cannon City	Cannon	7	4	100
Dundas Mills	E. T. Archibald & Co.	Dundas	Cannon	9	8	200
Northfield Mills	Jesse Ames & Son	Northfield	Cannon	10	10	300

Surface Features and Soil.

The eastern portion of the county is, for the most part, a high and gently rolling prairie of great beauty and fertility.

Skirting the small streams there is a little timber, and along the east bank of the Straight river—and also of the Cannon, from its junction with the Straight northerly to Dundas—there is a belt of timber averaging about 3 miles wide. The soil bearing this belt of timber is sandy with gravel subsoil, and is of comparatively little value for agricultural purposes.

The surface of the southwest part of the county lies above the Trenton formation and is gently undulating.

The surface of the northeast part is more broken because the Trenton is largely carried away and the St. Peter sandstone is eroded to quite variable depths.

The western portion of the county also is quite undulating—sometimes rough and hilly—and over the greater part is covered with heavy timber, interspersed with many beautiful but shallow lakes.

The surface soil is usually a dark loam, but is generally very thin. A strong and productive yellow clay overlying thick deposits of blue clay—which is frequently exposed—characterize the soil of this region. Maple, Elm and Basswood characterize the timber.

There are about twenty beautiful lakes in the western half of the county, ranging from one to ten square miles in area, and varying from ten to fifty feet in depth. These lakes abound in fish and are much frequented by sportsmen.

The southwestern part of the county, being lower and more sandy, furnishes better beaches for its lakes than are found further north where clay deposits overlie and conceal the sand.

I am under obligation to Surveyor Jewett, of Fairbault, through whose kindness I secured the following:

SURVEYOR'S NOTES OF RICE COUNTY.

Township 109, Range 19.—Richland.

Rolling prairie. Soil a black loam with clay subsoil. The north branch of the Zumbro river flows easterly through the northern part, taking the surface water of nearly the whole town.

Township 110, Range 19.—Wheeling.

Surface rolling, becoming bluffy along the creek. The east branch of Prairie creek heads near the center of the town, where there is a body of about one section of timber. This creek flows northeasterly, and forms a valley from one-eighth to one-fourth of a mile wide, about fifty feet below the general level of the prairie. From the bluffs along this valley in the north part of the town limestone crops out with sandstone below.

Town 111, Range 19.—Northfield.

Surface mostly a high rolling prairie sloping toward Prairie creek, which runs northeasterly through the township; a part of the town is drained northwesterly toward Cannon river. Soil a rich black loam; clay subsoil; limestone in bluffs along the creek; sandstone below.

Town 109, Range 20.—Walcott.

Surface rolling to hilly; slopes toward Straight river, which runs northerly through nearly the center of the town; a body of timber three to four miles wide lies on the east side of the river. Limestone appears in the bed of the river as far north as Sec. 4. North of this point it appears in the bluffs from 20 to 50 feet above the river. Soil in the river valley light and sandy with gravel subsoil; rest of town black loam over clay.

Town 110, Range 20.—Cannon City and Faribault.

Surface quite rolling; bluffy along the east side of river. The Straight river forms junction with the Cannon river in Section 30, from which point the Cannon river runs northeasterly to the centre of the north boundary. The two eastern sections are prairie; the remainder of the town is timber land: soil a rich loam with clay subsoil. Limestone crops out of river bluffs with sandstone below; a small lake in Sec. 15, containing 45 acres.

Town 111, Range 20.—Bridgewater.

Land rolling; becomes bluffy along the river as far north as Section 10. Cannon river flows northeasterly through the eastern part of the town. About six sections on east side of town are prairie; rest of town timber land; soil black loam with clay subsoil, excepting on river bottoms, where the soil is light and sandy over a gravelly subsoil; limestone in the bluffs along the river south of Section 10. In Section 1 it appears in the bed of river.

Town 109, Range 21.—Warsaw.

Surface rolling; drains toward the north; Cannon lake, with an area of 1475.28 acres, lies in the northwestern part of the township; four sections of land northwest of lake are timber land; rest of town is prairie and brush land; soil black loam over clay subsoil.

Town 110, Range 21.—Wells.

All timber land excepting Sections 35 and 36; surface rolling; soil black loam with clay below; area of meandered lakes 2114.44 acres; drains toward the south.

Rown 111, Range 21.—Forest.

All timber land; surface rolling; draining eastward; soil black loam, clay subsoil; area of lakes, 1694.41 acres.

Town 112, Range 21.—Webster.

Timber and brush land; surface rolling: drains to the south and east; soil light-colored loam over clay. Area of meandered lakes, 208.81 acres.

Town 109, Range 22.—Morristown.

Nine sections in southeast part prairie land; remainder of town timber. Cannon river flows easterly through the center of township; surface rolling, slopes towards the river; soil a rich black loam with clay subsoil. Area of meandered waters, 935.70 acres.

Town 110, Range 22.—Shieldsville.

Surface rolling, becoming hilly in some parts of the town; soil black loam over clay. Area of lakes, 2574.23 acres. The Cannon river heads in Tuft's lake, in Section 3.

Town 111, Range 22.—Erin.

Surface rolling to hilly, timber and brush lands; soil rich loam over clay. Area of lakes, 856.32 acres.

Town 112, Range 22.—Wheatland.

Surface rolling and hilly; soil black loam on clay subsoil; timber and brush land. Area of lakes, 307.27 acres.

Timber.

As before stated the eastern portion of the county originally produced timber only along the streams. Through cultivation for shade, hedges, protection from winds, &c., timber is increasing over this area.

The western half of the county was originally covered with heavy timber—excepting a few limited, enclosed spaces, which were open prairie, or sparsely covered with oak and under-brush—and forms a part of what is denominated the "Big Woods."

This region is being cleared up rapidly and there are now many fine farms in every township of the timber regions of this county.

The following list embraces all the native trees and shrubs that were noticed during the survey. It is not believed, however, that it includes all that grow naturally in the limits of the county :

Basswood. Tilia Americana. *L.*
Smooth Sumach. Rhus glabra. *L.*
Jersey Tea. Ceanothus Americanus. *L.*
Sugar Maple. Acer saccharinum. *Wang.*
Silvery Maple. A. dasycarpum. *Ehr.*
Red or Swamp Maple. Acer rubrum. *L.*
Box-Elder. Negundo aceroides. *Mœnch.*
False Indigo. Amorpha fruticosa. *L.*
Locust. Robinia Pseudacacia. *L.* Cultivated.
Cherry. Prunus.
Red Raspberry. Rubus strigosus. *Michx.*
Blackberry. R. villosus. *Ait.*
Crab. Pyrus arbutifolia. *L.*
Dogwood. Cornus paniculata. *L'Her.*
Wolfberry. Symphoricarpus occidentalis. *R. Br.*
Ash. Fraxinus.
Slippery Elm. Ulmus fulva. *Michx.*
Butternut. Juglans cinerea. *L.*
Walnut. Juglans nigra. *L.*
Hickory. Carya.
Burr Oak. Quercus macrocarpa. *Michx.*
Black Oak. Quercus coccinea. *Wang.* Var tinctoria. *Bartram.*
Wild Hazle-nut. Corylus Americana. *Walt.*
Iron-wood. Ostrya Virginica. *Willd.*
American Aspen. Populus tremuloides. *Michx.*
Cottonwood. P. monilifera. *Ait.*
Large-toothed Aspen. P. grandidentata. *Michx.*
Balm of Gilead. P. balsamifera. *L.* Var. candicaus. *Ait.*
Red Oak. Quercus rubra. *L.*
White Oak. Quercus alba. *L.*
Wild Plum. Prunus Americana.
American Elm. Ulmus Americana. (*Pl Clayt.*) *Willd.*

American Crab. Pyrus Coronaria. *L.*
Black Cherry. Prunus serotina. *Ehr.*
Bitternut. Carya amara. *Nutt.*
Wild Red Cherry. Prunus Pennsylvanica. *L.*
Thorn Apple. Cratægus Crus-galli. *L.*
White Birch. Betula alba. *Var.* populifolia. *Spach.*
Small Cedar. Juniperus Sabina. *L.* *Var.* procumbens.
White Pine. Pinus Strobus. *L.*
Water Beech. Carpinus Americana. *Michx.*
Cornel. Cornus paniculata. *L'Her.*
Cornel. Cornus circinata. *L'Her.*
American Woodbine. Lonicera grata. *Ait.*
Juneberry. Amelanchier Canadensis. *Torr & Gray.*
Dwarf Wild Rose. Rosa lucida.
Pipe Vine. Aristolochia Sipho.
Grape. Vitis cordifolia. *Michx.*
Virginia Creeper. Ampelopsis quinquefolia. *Michx.*
Nine Bark. Spiræa opulifolia. *L.*
Bittersweet. Celastrus scandens. *L.*
Rose. Rosa blanda. *Ait.*
Lombardy Poplar. P. dilitata. *Ait.*
Speckled Alder. Almus incana. *Willd.*

GEOLOGICAL STRUCTURE.

In general the drainage of Rice county is toward the north and east, which fact indicates the relative elevations.

The Chicago and Milwaukee R. R. survey (Minnesota Div.) found the elevations of the natural surface, where the railroad crosses the northern line of the county, to be over 1050 feet above the sea level. At Faribault depot it is 993 feet; at Dundas depot, 945 feet; at Northfield depot, 905 feet. The entire western half, and the southeastern portions of the county have a higher elevation. I have no means of knowing positively the relative elevations or the highest point in the county; but judging from appearances I conclude that the rolling prairie, on which Cannon City is located, is the highest by least 100 feet.

The only geological formations that appear in this county are the

Loam,
Drift,
Trenton Limestone,
St. Peter's Sandstone,
Shakopee Limestone.

In *general appearance* these formations are not unlike the same formations as they are seen in other portions of the State, and carefully described by Professor Winchell in his reports made during the past few years. Nor did I find in the county any remarkable *special peculiarities* in any of the formations.

The *Loam* is deep, dark-colored and fertile, over nearly all the eastern portion of the county; but over the western portion as a rule it is thin.

Drift, consisting largely of blue clay over-lain by a grayish yellow clay, characterizes the soil of the western half of the county. Boulders of granite, gneiss, trap and porplyry are quite abundant in some places; but fine clay, with small quantities of gravel, are the rule throughout this region. No well yet dug in the western part of the county has passed through the blue clay—though some of the wells are over 100 feet deep. A hint as to the depth of the clay is found in the fact that a well dug last season south of Rice county, about 30 miles west of Owatonna—near Janesville—after passing through 200 feet of blue clay reached a sandstone said to be identical with the St. Peter's in appearance. An abundance of good water, which rose to within 30 feet of the surface, was found between the clay and the sandstone. This fact should be considered by the residents of this drift and timber region, as many of them have failed to secure good and abundant water in the clay. Indeed there is much uncertainty about getting *good* well water in this region. Some holes at 100 feet or over fail to bring enough water for drinking and cooking purposes. Some wells that furnish an abundance of water are so strongly impregnated with mineral impurities as to be nearly useless, while others are quite pure. It is possible that good water which would rise nearly to the surface might invariably be procured by boring through the clay to the under-lying rock.

Illustrations of the peculiarities of the deposits in this region are seen in the following facts: On the S. E. side of Union Lake (7 miles west of Northfield) Mr. B. Benton dug 40 feet and secured an abundance of water, but is strongly impregnated with some mineral impurities. About 40 rods from there Mr. M. J. Punk secured better water at 16 feet; and about 40 rods further Mr. S. A. Amsden secured nearly pure water at a depth of 36 feet.

It has been supposed by some that the formation underlying the drift throughout the timber region is the Cretaceous, and I see that Prof. Harrington in his report on Steele county expresses his belief in the existence of the Cretaceous along that belt. I am not satisfied that such is the fact. To my mind there is but very little

evidence of it; but I do not desire to discuss ths matter till I have procured more light on the subject. At present my belief is that the drift rests immediately upon a thin remnant of the St. Peter sandstone. Perhaps in some places the St. Peter is all eroded so that the drift rests immediately upon the Shakopee.

Reference to the accompanying colored map of the county will show the areas of the different formations as they give evidence, by exposure and by topography, of underlying the deposits of drift and loam.

It will be seen that the Trenton limestone is nearly removed from the western part of the county, the bluffs along the Straight river to a point a little south of Faribault, and a hill near Northfield, being the only places where it occurs. East of the river, however, it is extensive, and furnishes abundance of material for building purposes of which mention will be made under the head "Material Resources."

In general character the Trenton resembles so closely that found in other parts of the State, and so carefully described in previous reports on the survey of the State, that little need be said here.

For building purposes the most of that found in this county is superior to that quarried near St. Paul, in that it contains less clay and does not weather so easily. On the other hand the Rice county limestone contains more concretionary iron pyrites, and, hence, necessitates more care in its selection for architectural purposes.

The Straight river cuts through the Trenton and enters upon the St. Peter at Walcott's mill, 3 miles south of Faribault. At a point eight miles further north the river (having now become the Cannon) has worked its way through the St. Peter and enters upon the Shakopee. The thickness of the St. Peter, in Rice county, is from 100 to 125 feet. It appears in the form of cliffs at frequent points along both sides of the river from the place where it is first reached by the Straight to the northern limits of the county, and in the northeastern part of the county it frequently appears in the hills—indeed it largely gives character to the topography of this section.

Judging from the topography also I am satisfied that many of the hills in the northwestern part of the county—in Wheatland and Webster townships—consist largely of the St. Peter; but they are so heavily covered by drift and timber that I could neither find nor learn of any exposures. In Cedar Lake there is an island the topography and flora of which indicate the St. Peter, capped with Trenton. I was unable to verify this by excavations.

There is no place in the county where the St. Peter sandstone is sufficiently compact and firm for building stone. As along the

Mississippi, it may be removed by pick and shovel. In color it is—as along the Miss. river—white to red, according to the percentage of iron, and its oxidation resulting from exposuse. No fossils are found in it here.

The Shakopee limestone is reached by the Cannon river at a point about 4 miles south of Dundas—6 milns south of Northfield. On leaving the county one-half mile north of Northfield, the river has cut into the Shakopee about thirty feet. The map shows approximately the extent of this formation as exposed. The descriptions of it in preceding reports will apply to the formation as seen here.

Material Resources.

Limestone—both for building-stone and for quick-lime—and sand for mortar, are abundant along the valleys of the Cannon and Straight rivers, and throughout the western half of the county; while in the western portion no limestone is found.

Good clay for the manufacture of brick is sufficiently abundant all over the county.

Stone Quarries

are abundant throughout the eastern half of the county. The bluffs throughout this region are capped by a layer of the Trenton varying from a few inches to several feet in thickness.

The various neighborhoods of this section have their quarry, or quarries, from which all the building stone for general purposes is easily obtained.

Prairie Creek Valley has scores of quarries opened along its bluffs; and the valley of the Cannon looks up to as many more. Good coursing-stone is furnished at Northfield for about $6 00 per cord.

At "Fall Creek," 3 miles east of Faribault, there is a fine deposit which is being extensively quarried by its owner, Mr. Phillip Cromer. The deposit of limestone here is about 12 feet thick and is covered by about 4 feet of drift and loam. The strata in this quarry range from 3 to 12 inches in thickness and are easily quarried. The upper stratum, 8 inches in thickness, is quite light-colored and filled with fossils which are so thoroughly cemented and transformed as to render the stone compact, while its fossiliferous nature is still clearly apparent. But few specimens of fossils can be enucleated. The rock is infiltrated by gypsum and Iron Pyrites which often cement its seams quite firmly.

Mr. Cromer sells undressed stone for prices ranging from $5.00 to $15.00 per cord. The greater part of his business however is in the best varieties, which he sells by the cubic foot, at prices ranging from 25 cents to 75 cents.

Mr. N. Lord, 2 miles south of Faribault on the west side of the river, has two quarries opened, from which he has sold as high as 300 cords in one year.

In Richland township, bordering on Goodhue county, Messrs. Halver Johnson and Peter Halverson have each a fine quarry at which I saw about 100 cords ready for market.

Messrs. I. Lenhart, A. Revere, C. Stetson, D. Furguson and P. Oleson are the principal quarrymen in the vicinity of Northfield; and on Prairie Creek, in Wheeling township, Messrs. J. Thompson, A. Knapf and S. Aslagson do quite an extensive business in quarrying for their neighbors.

Lime Kilns.

The upper four strata of the Lower Trenton formation as exposed in this county furnish tolerably good material for quick-lime, though in some places the deposit is too silicious, and in no place is the lime obtained sufficiently white for fine work. When first burned the lime is yellowish in color, but when slacked is nearly white. It is excellent lime for stone work.

Though lime has been burned in every township of the county east of the Cannon river, it is not now made a regular and paying business except at Phillip Cromer's kiln, on Fall Creek, near Faribault. Mr. Cromer uses a patent kiln and burns from 3,000 to 3,500 barrels a year, which he sells at 65 cents per barrel. Three other kilns near Fairbault, owned respectively by Messrs. Pond, Lee and Lord, burn in the aggregate about 1,000 barrels per year. There is a kiln one mile from Northfield, in Dakota county, which supplies Northfield and vicinity. This kiln burns its lime from the best strata of the Shakopee formation. In general character the lime is like that of the Trenton.

Brick.

Rice county contains an abundance of clay for the manufacture of brick but none has been found sufficiently free from iron to make the white or cream-colored brick. At Faribault Mr. J. G. McCarthy makes about 700,000 per year, which he sells at $6.00 per thousand. One season he made one million. All the clay of this section is so clear that to make good brick it is necessary to add sand.

Henry Durham, of Faribault, burns about 300,000 per year and finds lying immediately under the clay a stratum of sand for mixture with it.

Another brickyard has been started at Faribault this season. Its character and success are not determined. At Prairieville, Messrs. Meisner and Leonard are making about 300,000 per year. Their brick are said to contain considerable lime and to be very good. At Morristown, Mr. Pettiel makes abont 50,000 per year. Three miles northeast of Faribault, Mr. Dungay is making the .best brick yet produced in the county. His product so far has been but about 100,000 per year, but these have been sold at from $7.50 to $8.00 per thousand. At Shieldsville one kiln is burned each year for home supply, and at Northfield one or two small kilns are burned every season.

During the past season a bank of clay has been opened about three miles from Northfield and brick for the new college building (St. Olaf's) have been burned. They are pronounced of fine quality.

In making the survey of this county I am especially indebted to Surveyor Jewett, of Faribault, for surveyor's notes of the county, to Professor J. J. Dow of the State Blind Asylum, at Faribault, for his valuable company and assistance during several of the days occupied in field work, and to Professor B. F. Thomas of Carleton College, who also rendered valuable assistance.

At some convenient time in the future I shall hope to make a *supplementary report* concerning some further facts and features pertaining to the Geology of this county.

IX.

CHEMISTRY.

REPORT OF PROF. PECKHAM.

Prof. N. H. Winchell,

My Dear Sir :—The chemical work for the Geological Survey during the last year has been as follows :

The analysis of the ashes of 17 specimens of peat.
The analysis of four specimens of peat as fuel.
The analysis of the water of the Belle Plaine salt spring, so-called.
The examination of 13 specimens of water from the Red River Valley.
The examination of 3 specimens of water from Brainerd.
The examination of three specimens of limestone, and of concretions from the brick clay at Minneapolis.

The results of the examination of the peat and peat ashes are herewith submitted. The water from Belle Plain was procured by myself about the first of last May. On reaching Belle Plaine I enquired for the spring from which the salt water had formerly been obtained and was informed that the bank had caved in upon it and it was filled up with earth. I was further informed that the water oozing from the base of the bluff was as salt as any water about there. I then enquired about the well and the possibility of getting some water from the boring. I was informed that no water could be procured from that source as the pump had been taken out and the level of the water was many feet from the surface. The station agent confirmed this information and I saw no other resource but to collect such water as I could from that flowing from the bluff. I brought this to the Labratory and soon found that this specimen was nothing more than hard well water, confirming the results of the examination that I made in 1873-4. I afterwards met a gentle-

man who resided in Belle Plaine, who confirmed the statement previously made to me that I had probably got a specimen of as salt water as any that was to be had there now.

Having ascertained that there was a comparatively small amount of solid matter in the water, of which only a very small proportion was chlorides of any kind, that the water contained principally bicarbonates of lime and magnesia with some sulphates and chlorides; in fact, as stated above, that the water was nothing but a hard well or spring water, I concluded that it would be useless to make an estimate of the gasses dissolved in the water, or of the substances contained in small quantity, and therefore after completing the estimates then begun I did not continue the examination further.

But one of two conclusions can be entertained in reference to these results; either the wrong water has been examined or the Belle Plaine salt springs do not yield salt water. I purposely avoided seeking any parties at Belle Plaine who had been hitherto interested in the salt operations there, as I did not wish to prejudice my results for or against any persons or interests.

The examination of the specimens of Red River water made during the summer vacation have been previously reported upon.

The examination of the water from Brainerd has been already reported upon.

The Belle Plaine Water.

Mineral matter in solution		25.10	grains to gall.	
Organic and volatile matter in sulution		5.37	"	"
Total solid matter in solution		30.47	"	"
Chlorine, Cl		3.152	"	"
Silica, SiO_2		1.465	"	"
Ferric, aluminic and phosphoric oxide	Fe_2O_3, Al_2O_3, P_2O_5	.068	"	"
Barium sulphate	$Ba\,SO_4$	A trace	"	"
Sulphuric oxide	SO_3	1.033	"	"
Lime	CaO	5.896	"	"
Magnesia	MgO	.544	"	"

Alkalies and carbonic oxide (CO_2) were not determined.

Peat Ashes.

Number.	Silica, SiO_2.	Carbon.	Iron and Iron Phosphate. Fe_2O_3 and $Fe_2P_2O_8$.	Lime, CaO.	Magnesia, MgO.	Sulphuric Acid, SO_3.	Undetermined.	Remarks.
16	51.30	1.81	9.30	10.89	6.12	5.19	15.39	CO_2 and H_2S in large amount.
17	83.13	.86	7.99	5.44	1.75	.78	.05	Alkalies a trace.
18	83.35	.03	5.29	7.39	.97	2.57	.40	Alkalies a trace.
19	72.79	.95	9.46	5.92	6.13	trace	6.25	CO_2, small ; Fe_2P_2O8 5.92.
20	80.55	.75	10.23	5.61	.76	1.34	......	CO_2, trace P_2O_5 trace.
21	82.71	1.19	7.41	3.18	trace	3.70	1.81	CO_2, a trace.
22	64.37	.16	21.41	6.26	1.54	7.58	......	P_2O_5 a trace.
23	72.64	.75	15.46	5.87	trace	5.73	......	P_2O_5 a trace.
24	68.06	1.34	8.82	5.03	4.81	6.[illegible]	......	CO_2 strong ; P_2O_5 trace.
25	88.28	1.32	6.34	.84	.51	trace	2.71	CO_2 very small ; P_2O_5 & Alkalies a trace.
26	64.27	2.80	9.75	15.75	1.77	3.69	2.57	CO_2 very strong, P_2O_5.
27	81.99	1.14	9.39	4.84	.60	1.12	......	P_2O_5, Alkalies a trace.
28	79.24	.15	5.65	7.60	.98	2.76	3.62	CO_2 strong, Alkalies a trace.
33	57.23	1.45	16.50	11.47	2.09	8.71	2.55	CO_2 strong.
34	57.35	1.48	17.09	17.84	trace	4.79	1.45	CO_2 strong.
35	55.30	5.57	11.26	19.04	trace	3.26	5.57	CO_2 strong
36	63.71	1.60	10.50	11.83	3.98	2.70	5.60	CO_2 strong.

No.	Total Volatile.	Total Combust.	Ash.	Remarks.
33	7.97	43.34	48.69	Had been dried about three years.
34	8.03	45.32	46.65	Had been dried about three years.
35	13.43	70.96	15.61	Had been dried about three years.
39	12.37	67.14	20.49	Had been dried about three years.

Nos. 46, 47 and 48 are limestones.* They were examined for the total amount of matter insoluble in hydrochloric acid, water, iron, alumina, phosphate of iron, lime and magnesia in the soluble portion. As there was only a trace of soluble silicate and phosphates the lime and magnesia were calculated as carbonates. No. 47 gave a small per cent of alkalies, not an unusual ingredient of lime stones. Nos. 46 and 48 gave only a trace of alkalies.

*No. 46 was a sample of the common building-stone from Minneapolis—"No. 5" of the section below the University. Report for 1876. p. 149.

No. 47 was a sample of the building-stone from Taylor's quarry. near Fountain, Fillmore county, and was compact and non-argillaceous.

No. 48 was a sample of the impure limestone from Minneapolis, from "No. 1" of the section below the University. Report for 1876, p. 148.—N. H. W.

Analysis gave the following results:

No. 46.

Portion insoluble in hydrochloric acid	14.45 per cent.
Water (H_2O)	1.60 "
Ferric oxide (Fe_2O_3), Alumina (Al_2O_3) / Ferric phosphate ($Fe_2P_2O_8$)	1.70 "
Carbonate of Lime ($CaCO_3$)	75.482 "
Carbonate of Magnesia ($MgCO_3$)	6.810 "
	100.043 "

Alkalies, sulphuric acid and solouble silica, of each a trace.

No. 47.

Portion insoluble in hydrocloric acid	9.890 per cent.
Water (H_2O)	0.240 "
Ferric oxide (Fe_2O_3), alumina (Al_2O_3) / Ferric phosphate ($F_2P_2O_8$)	1.300 "
Carbonate of Lime ($CaCO_3$)	86.107 "
Carbonate of Magnesia ($MgCO_3$)	00.470 "
Alkalies	.440 "
	99.447 "

Sulphuric acid and soluble silica, of each a trace.

No. 48.

Portion insoluble in hydrochloric acid	16.220 per cent.
Water (H_2O)	0.375 "
Ferric oxide (H_2O), Alumina)Al_2O_3) / Ferric phosphate ($Fe_2P_2O_8$)	3.075 "
Carbonate of Lime	54.533 "
Carbonate of Magnesia	36.002 "
	100.205 "

The magnesia is a fraction of one per cent too high. Alkalies, sulphuric acid and soluble silica, of each a trace.

These results would give these limestones the following values for burning into lime. If completely burned,

100 pounds of No. 46 would give 61 pounds of lime.
" " " " 47 " " 60 " " "
" " " " 48 " " 62 " " "

Of the 61 pounds of No. 46, 45.5 pounds are available for mortar.
" " 60 " " " 47, 49 " " " " "
" " 52 " " " 48, 42.5 " " " " "

The mortar from Nos. 46 and 47 would be nearly a pure lime mortar, that from No. 48 would be one-third a magnesian mortar.

One houndred pounds of pure carbonate of lime will yield fifty-six pounds of lime, after burning, all of which would be available for mortar.

Practical results would vary somewhat from the above as more or less skill was exercised in burning the limestone.

No. 54. Lime Concretions found in the Brick Clay at Minneapolis.

Matter insoluble in hydrochloric acid, chiefly Fe_2O_3	4.62	per cent.
Calcium Carbonate	94.83	"
	99.45	"

There was also a trace of magnesium carbonate and organic matter.

Feb. 25, 1878.

Report on Serial Nos. 49, 50 and 51, Well Waters from Brainerd.

Owner's Name.	Serial Number.	Total Solid Residue.	Mineral Residue.	Organic and Volatile Residue.	Permanent Hardness.	Removable Hardness.	Total Hardness.	Chlorine.	Free Ammonia—Pts in 100,000,000.	Albuminoid Ammonia—Pts in 100,000,000.	REMARKS.
C. H. Alsop...	49	31.287	24.283	7.004	8.172	6.421	14.593	42.728	132.	49.	Sulphuric and Carbonic acids, a trace.
Al. White.....	50	16.519	13.250	3.269	6.129	3.210	9.339	4.027	0.	9.	" "
Leland House.	51	37.241	30.937	6.304	9.923	4.378	14.301	50.900	26.	13.	" "

These waters are very unlike. No. 49 is a hard well water, very bad indeed from free and albuminoid ammonia. The latter might be derived from decomposing vegetation, but the free ammonia in such large quantities gives unmistakable proof, in the absence of other causes for its presence, of sewage contamination. No. 49 also contains a very large proportion of chlorine which is also proof of contamination. No. 50 is a pure well water, somewhat hard, but very free from ammonia in any form. The amount of chlorine is also small. No. 51 is harder than No. 49. It contains less ammonia than 49 but still sufficient to indicate contamination, especially when considered with the large amount of chlorine that it contains. All three of these waters contain only a trace of sulphuric acid SO_3 and a very little carbonic acid (CO_2). In waters containing so much chlorine it is useless to attempt to estimate calcium and magnesium with soap; the method of Parke's does not answer, excepting for those waters containing carbonates as I have stated in a former report.

Nothing in the appearance of these specimens would indicate that there was any difference between them or that they were unlike ordinary well or spring water.

Respectfully submitted,
S. F. PECKHAM.

MINNEAPOLIS, MINN., Dec. 11th, 1877.

P. S.—Dec. 29th. In 49 and 51 the chlorine appears greater in amount than the total solid matter. This chlorine is correct and doubtless exists in some volatile form. There was not water enough for me to ascertain to what cause the discrepancy is due, but the reason assigned above is I think adequate.

S. F. P.

X.

ENTOMOLOGY.

REPORT OF ALLEN WHITMAN.

Prof. N. H. Winchell, State Geologist:

SIR:—I have the honor to contribute to The Geological and Natural History Survey of Minnesota the following entomological notes for the year 1877. They refer mostly to the locust, with the disappearance of which we are left once more to contend only with some of the common pests of the garden, and of fruit, shade and forest trees. In this respect we are fortunate that we still lie outside of the range of some of the most pestilential enemies of the grain and corn fields; and although a persistent cultivation of any growth will probably bring in time all the insect enemies of that growth which are capable of existence and reproduction here, we are subject for the present only to the attacks of enemies not numerous in species nor excessive in number when compared with those of longer cultivated and more thickly settled States. These however are troublesome enough and are attracting more and more the attention of our horticultural and agricultural societies, as they have already attracted that of the few gentlemen in the State who have been able to devote to the study of Entomology a portion of the time largely due to other pursuits.

It is hardly the work of the Geological and Natural History Survey to furnish instruction in elementary or economic entomology. Circumstances have made it seem necessary or desirable to collect all possible information on the subject of the locust, particularly that species which has become so well known in this State of late years, in regard to which much is still to be learned, and which is still a kind of fabulous bugbear to those States which are free from it. For the purpose of completing what has already been written in previous reports, the subject is here continued. But that there are other insects in regard to whose habits, together with the best means of protection from them, our farmers and gardeners could be profitably instructed, is shown by

the attention which has been paid to the subject during the past year at the meetings of our horticultural and agricultural societies, and by the (unsuccessful) attempt made in the last legislature to obtain a meagre appropriation for the purpose of issuing a pamphlet to meet the supposed need of it. It is too often the case that the inability to provide against injuries results from a lack of that knowledge of the growth and transformation of insects that ought to be in the possession of even the children in our common schools; while many pests which are practically known to every gardener while in their destructive stage, are wholly unknown to him in those stages when they are preparing to commit future injury. The State Entomologists of Missouri and Illinois (and perhaps other States,) have considered it worth their while to preface their earlier reports with brief manuals of elementary entomology. A small pamphlet of this kind with brief notices of the form, growth and habits of some of our most common species of injurious insects might be issued by the Agricultural Department of the State University (as has been done at the Agricultural College of Michigan,) and would render great service. In addition to this every one who is interested in the matter may contribute by sending to the Museum of Natural History at the State University, specimens of every kind of destructive insect, in all forms or stages of it that are capable of preservation. A collection formed in this way would in time become of great practical value, and at the meetings of the horticultural and agricultural societies at Minneapolis, would become available to a large number of persons.

Not to go outside of our cities, a large percentage of the yearly injury or ruin to our shade trees, is occasioned or increased by insects, while oftentimes the owners entertain no suspicion of the cause of the evil. We set out maples again and again, to be seriously damaged by the havoc of boring-beetles or of the Maple Aegerian, while the box-elders are defoliated and rendered unsightly by the caterpiller of an insignificant yellow moth.

Outside of the cities, in addition to the damage inflicted by the locust, the Colorado Potato Beetle has done perhaps more injury than in any year since 1870, while certain blister-beetles and the potato-stalk weevil have been more noticeable than before. While this is in writing the report of the Hon. T. M. Metcalf, Commissioner of Statistics, for the year 1877, states that the Chinch Bug has committed considerable injury in Houston county during the year. As this is an enemy to a considerable extent unknown to our farmers, I add a few brief notes in regard to it, with the hope that they may be of some value, if the evil makes its appearance again this year.

Another insect which has appeared in far greater numbers than usual during the year is the Tent Caterpillar of the Forest, (Clisiocampa Silvatica. Harris.) [Vid. Harris' Report p. 375 and Riley's Third Annual Report of the State of Missouri.] These were abundant about Brainerd, as is shown by the following:

BRAINERD, MINN., July 6th, 1877.

DEAR SIR:—I send you by express a few specimens of the army worm. East of this place they are very abundant, and the northern limit of this caterpillar is unknown. They have been observed one hundred and fifty miles north of us (by the Mississippi river) on that stream.

They eat the oak and bass wood only. In the vicinity of Island Lake on the line of the N. P. Railway, they have been very plenty, but are decreasing, advancing southward.

Yours most truly,
J. C. ROSSER.

The following extract probably refers to the same insect:

"The caterpillars have again made their appearance in large numbers in the timber in the vicinity of Eagle Lake, and are eating the foliage of the trees, in many instances almost stripping them bare. Last year they occupied the same district, covering a district from four to six miles in extent. This year they are more numerous, and we suppose are gradually extending their operations."—*Mankato Review, June 12th, 1877.*

The works referred to above describe this insect very fully, and give the means of preventing its increase.

THE ROCKY MOUNTAIN LOCUST.

The area of the egg deposits for the year 1876 will be found on the "Map of Locust Areas," in the report of the Geological and Natural History survey of that year. The statements upon which this was based came from over six hundred townships in about forty counties. The reports as to the density of these deposits varied greatly in the different counties. It was generally thought that there were very few or no eggs along the Dakota line, and in most of the territory where the young had hatched in 1876; that they were more numerous along the eastern line of the egg-area, where however but comparatively few appeared in the Spring; and more numerous still in a strip of country reaching southeastward from Otter Tail to Blue Earth and including those counties, and in fact it was in this strip of territory out of all the locust region from Minnesota to Texas, that the greatest damage of the year 1877 occurred. The eggs were also thickly laid in the southern range of counties from Rock to Freeborn as well as in nearly every county in Iowa lying south of these, but all this portion of the locust region, both in Minnesota and Iowa, escaped with far less damage than had been expected, and in nearly every case with the best crops known for years.

PROGRESS DURING THE SPRING.

The locust events of the spring and summer were a succession of hopes and disappointments, ending finally in a large measure of unexpected success. The warm weather of February, followed by severe cold in March, seemed to exert in most cases no appreciable effect upon the vitality of the eggs. It was forgotten that the weather reports of March and April for the past four years would

show that the eggs are almost every year subjected to more or less freezing and thawing. When the hatching time came the young failed, for various causes, to appear in large numbers, in many places where the eggs had been laid at least as thickly as in previous years; but on the other hand they came forth in such overwhelming numbers in other places, that the unequal conditions of the different parts of the locust area, added to all the uncertainties of what the next few weeks would bring, rendered the loosely drawn and self-contradicting bounty law* of 1876 an obvious failure, and no steps were ever taken to carry it into effect. The prospect during the last ten days of May was disheartening. In thirteen counties, in parts of some and in nearly the whole of others, clean sweeping destruction of wheat and serious injury to many other crops were already in progress, while in about twenty other counties the young had appeared in sufficient numbers to cause great apprehension. From the first of June onward there was marked improvement; where the locusts were excessively numerous and where the wheat had been trimmed to the ground at that date, the crops failed to recover; but where the growth still remained or had not been badly eaten, the comparative amount of injury grew less from day to day until the crops for the most part were safe except from migrating swarms. Then followed a series of migrations in July and August, which though they added a little to the territory already injured, were so different from those of other years as to be mainly harmless. The result of all this was far different from anything which could have been expected in May, and the returns of the Commissioner of Statistics for 1878 will probably show that the locusts destroyed more bushels of grain in 1877 than have been

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GENERAL LAWS OF MINNESOTA FOR 1877; CHAPTER 86.—The act appropriates $100,000 for the destruction of grasshoppers and their eggs. The bounty is to be paid only to persons living within counties affected by grasshoppers. The sums to be paid are as follows: fifty cents per gallon for eggs; one dollar per bushel for grasshoppers caught previous to the 25th of May; fifty cents per bushel from the 25th of May to the 10th of June; twenty-five cents per bushel from the 10th of June to the 1st of July, and twenty cents per bushel from the 1st of July to the 1st of October. Instead of "caught" it would be better to use the word "delivered," for obvious reasons.

Other sections provide for the delivery of captured grasshoppers to measurers appointed (by the Governor) for each township, and for payment of bounty through certificates issued by county auditors, audited by boards of county commissioners, filed with the State Auditor, and paid with his warrant upon the State Treasurer. Although the provisions of the act extend to October 1st, the money appropriated by the act can be applied only to the payment of certificates filed with the State Auditor on or before July 15th. If the amount of these certificates exceeds $100,000 they are to be paid by the State pro rata to the amount of $100,000, and the balance in full paid by the counties according to the amounts due on certificates issued by each county. Furthermore; "no other or greater amount than $100,000 shall ever be paid under the provisions of this act."

It is entirely an unfair proportion between the price to be paid up to May 25th (one dollar per bushel, which is none too much) and from June 10th to July 1st, (25 cents per bushel,) when the locusts are in the pupa or winged state, and may easily be caught by the barrel, after nightfall. One farmer estimated the amount caught by him at this period at 400 bushels; another at 800 bushels. Besides this, it was obvious before May ended that a few of the worst infested counties would easily exhaust nearly the whole appropriation, perhaps without saving any great amount of crops; while others (which finally escaped almost unharmed without any use of the bounty law,) would have to be responsible for nearly the whole of its bounty certificates.

Other sections provide for one day's labor per week of all males between twenty-one and sixty, in the several townships of the afflicted counties, for five weeks after the grasshoppers become large enough to be caught easily; such labor to be performed under the direction of overseers of highways, who are to give notice of the time and place where it is required.

This is liable to call a man away from the defence of his own field at the very time when he is most needed at home. The same amount of labor, assessed *before the grasshoppers hatch*, in destroying eggs, or in ditching to prevent incursions, would prove far more effective.

destroyed in any other year, and that the amount left to harvest fully equalled any annual crop yet produced.

The causes of this unexpected result are for the most part a series of favorable climatic conditions. As in the year 1876 the returns of locust damage inflicted mostly in July and August, included a considerable diminution of the wheat crop by drouth in June, so, on the other hand, counties harvesting a full average crop in 1877 will probably report no damage, even where the crop was really somewhat reduced by the locusts. For once, the farmer, taking the annual chances of rain, hail, blight, drouth, insects and other destructive agencies to which he is from time to time subjected, has found the influences of climate to be so largely in his favor as to offset what otherwise promised to be an unmitigated evil, and if it is not probable that the state will be often overrun by locusts in any series of years, it is still less likely that in any one "locust-year" the hatching will again be reduced to a nullity through so large a portion of the egg-area. But that events of this kind do actually repeat themselves in the long run, is shown by the fact that the locust events of 1857 (so far as they can be recalled) are almost exactly repeated in 1877, in the thick deposit of eggs, in the character of the spring weather, in the damage which proved less than anyone had expected, and in the final departure of the migrating swarms in July and August to some unknown destination from which they failed to emerge in great numbers for several years. Of course all that is here stated of the successful results of the harvest of 1877 is said with a full knowledge of the sweeping destruction in some of the worst ravaged counties, but also with a consideration of all those counties where the locusts failed to inflict injury, and where it would have surely followed in a spring resembling that of 1876.

Other and less considerable causes tended to reduce the expected percentage of injury. These were, a certain but hardly calculable amount of destruction of the eggs by insect and other enemies, and a partial failure of the eggs to hatch, "from causes unknown;" a comparatively trifling destruction of the young by snow storms at the end of April; and, more efficient wherever applied, the destruction of the eggs by plowing and harrowing the egg-beds during the fall and spring, and the destruction of the young with ditches, tar-pans, nets, and other contrivances. To this must be added that in some cases where the young were fully as numerous as in other years they were far more harmless, and also that eggs deposited in September and October, 1876, were hatched so late that the crops were mostly beyond the reach of the young.

HATCHING.

The cases of reported hatching in February were, so far as ascertained, entirely the appearance of native species. All of those sent me were of a size that generally precluded the possibiltty of their having hatched in February. Three of our common native species were received, of which two became winged in the first week of March, but neither of the same species was observed in the fields until the 25th of May. The young (perhaps of Spretus) were seen

in our southern counties by the 10th of April, and by the 20th of the month had appeared in considerable numbers along the river bluffs between St. Peter and New Ulm. Part of these, and perhaps all, were destroyed by a storm which came about a week later, but they were only a trifling portion of all that were to appear. Innumerable newspaper items, letters, and replies to circulars show that it was not until the first ten days of May that the eggs hatched in greatest numbers, with slight difference between the dates of appearance in the northern and southern counties.

LATE HATCHING.

It was noticed everywhere that the hatching of 1877 was more prolonged than usual. This was in part due to the dampness of the spring, but more to the fact that eggs had continued to be deposited much later than usual in the fall of 1876. A case reported in 1875, when a single swarm alighted (at Waterford, Dakota Co.,) on the 18th of October and deposited eggs which did not hatch until the 20th of the following June, gives an opportunity of observing how much the late deposits are behind the early ones in the time required for hatching. Eggs left late in the season in this way wintered over in a fluid condition, which often created an impression that they were rotten, but I had no difficulty in hatching such with a three weeks' warm exposure. These finally hatched in the fields, but in most cases too late to do much injury. Their final exodus from the hatching grounds was also two to three weeks later than elsewhere, and on the 8th of July, when the locusts had all acquired wings, and had entirely left the neighborhood of Glencoe, I found. a few miles farther west in Renville county, the young in about the same stage of advancement that I had seen around Mankato on the 21st of June, from one-third to two-thirds still in the pupa-stage. But in general, where injury was severe, it was only in places where the young had been numerous as early as the last week of May, and it is only in an excessively dry year, with a slender growth of grain, that the crops are likely to be badly injured by the young that hatch after the first of June.

FAILURE IN HATCHING.

Throughout a large number of counties, and perhaps throughout the whole egg-area, a certain percentage of the eggs failed to hatch. In limited areas the failure was so great as to amount to almost complete exemption from injury. It is difficult to calculate what percentage of the eggs thus failed, but there is no doubt that it was often a large one. It is the opinion of those in Nobles county who have interested themselves in observing such matters, that eggs have never been laid so thickly in that county as in 1876, but hardly a wheat field was destroyed by the young in 1877. While this is in writing I have received brief reports from nearly every locust county in Iowa. There as in Minnesota, the hatching was in many cases far less numerous than

the extent of the egg-deposit had led people to apprehend, and in others the injury resulting from the great number which did hatch was much less than usual. The result is condensed by Prof. C. E. Bessey, of Ames, as follows: "In the fall of 1876 they (the locusts) laid many eggs in Central Iowa. In the spring of 1877 they hatched, but for some reason, not known to me, (nor any one else hereabouts,) they did not amount to much."

The causes of failure in hatching are generally stated to be "unknown." They are no doubt the unusual temperature and rainfall of the spring and the action of the Silky Mite and various grubs. It is precisely in those counties of Minnesota and Iowa where the locust evil has been most permanent for the last five years that the eggs have been apparently destroyed, while the territory of densest hatching and most sweeping destruction in Minnesota lies almost entirely outside of what has been the region of greatest and most continuous damage for the last five years. As the persistent cultivation of any growth is followed by a corresponding increase of its insect-enemies, so the increase of these insects is followed by multiplication of the parasites and enemies which prey upon them. The destroyers of the locust eggs, not endowed with the same efficient powers of locomotion as the locust itself, are confined to a smaller range and continue to multiply within it, and where the locust deposits eggs for a series of years within the same range, its enemies will in time multiply, rarely perhaps in sufficient numbers to overpower the locust, but sufficiently, when aided by other favorable conditions, to produce a marked diminution of the species; while to preserve the balance still further the locust carries its own enemies with itself to other laying-grounds not only in the germ of the slowly moving locust mite but of the swift Tachina Fly.

AREA OF GREATEST INJURY.

The greatest injury inflicted by the young during the spring, and in fact the area of all injury in the State worth reporting, was confined to a strip of country extending southeastward from about the centre of Otter Tail county to Lake Crystal, and lying along the edge of the timbered regions. On the east it was partly bounded by the timber, extending some little distance eastward into it in its northern part, (into Todd and Stearns counties), the hatching growing less as it progressed eastward, and finally failing almost entirely, except in open spots along the Mississippi. On the west the boundary was irregular. It was limited mostly by the line of what had been the most frequent cultivation in 1876, confined to river valleys and the points of thickest settlement, while as the farms became more scattered, (to the westward) the hatching thinned out, and finally ended almost entirely where stretches of unbroken prairie began. In general the swarms seemed to have progressed eastward (in Minnesota) in 1876 without halting to lay except in the vicinity of cultivation, and to have been checked in their progress by the timber and to have massed their forces along its edge. At any rate this region was a laying ground through the whole of the preceding season from the middle of July, through August and

sometimes into September. It is difficult to convey, to one who has not seen such sights, an idea of the immense numbers of the young that appeared in some parts of this infested region in the last week of May. The wheat fields covered with the young, and sometimes trimmed bare of every green blade, the low bushes by the roadside stripped of their leaves, the young locusts dancing into the air, and flickering like heat in the sunlight before the horses' feet in a ride of miles across the prairies, the road-beds blackened with the young basking on the warm sand, all these, which had then hardly begun their devastating marches, prophesied the injury which was destined to ensue. These were extreme cases, but elsewhere, where the numbers were less, the bands which came marching over the fields, one after another, finally sufficed to make way with nearly every crop within their reach. Later on, the wheat which had been left by the young in May was trimmed of its green leaves, and the stalks were left like spindles, blackening in the sun, while the locusts having destroyed about every crop (except oats) which happened to lie in their path, trimmed out the tender portions of the prairie grass and made it almost unserviceable for grazing. The oats, the foliage of which was hardly touched, were attacked while heading out, and the slender stems of the berry cut off, but generally something of an oat crop was harvested when there was hardly anything else left to gather.

A general, but hardly an organized warfare was waged against the young almost from the outset, every man defending his own fields as best he could. In the nineteen counties which the Hon. Commissioner of Statistics reports as more or less injured, the acreage of wheat was less by 113,700 acres than in the preceding year, but was still considerable, amounting to 337,000 acres. Of these counties eight showed an increase of wheat-acreage over 1876, while, of the remaining eleven, four counties sowed from three to six-sevenths less than in the preceding year. There were instances of men who, warned by former experience, sowed nothing whatever, as well as of men who sowed as largely as though no enemy were at hand; but far the larger majority were the cases of those whose only hope of a decent subsistence depended on such a crop as they might bring through to harvest. The energy with which most of these began the battle as soon as the young made their appearance, was worthy of all success. The usual methods of burning the young were resorted to at once, and in some cases ditches were run about the fields. Towards the end of May the coal-tar pan, which had been used in various forms in Kansas, Colorado, and elsewhere, came at last (after having been fully described during the preceding year,*)

*There was no reason why the use of coal tar, kerosene, &c., in pans or otherwise should have seemed a novel or providential invention to the people of Minnesota. The use of tar spread upon building paper was fully described in the Report of the Geological and Natural History Survey of Minnesota for 1876; a full description of the kerosene pan was sent broadcast in one of the "patent insides" of our country papers for the same year; a letter from Greeley, Colorado, dated August 5th, 1876, to the Farmers Union of Minneapolis, describes the use of coal-tar spread upon canvas, to be dragged over the grain; while in the proceedings of the Grasshopper Convention at Omaha, (page 51) the same instrument was described again. In spite of all this the use of coal-tar seemed absolutely unknown to the people of Minnesota until it was make known to them by the letters of the Hon. A. B. Robbins, of Wilmar, to the St. Paul Pioneer Press in May, 1877.

to the attention of the people of Minnesota, and was seized eagerly as an instrument that promised to be effective. For the next three or four weeks, wherever tar and sheet-iron could be obtained, men, women and children dragged the tarpan industriously over the grain fields, until the instrument became either useless or unnecessary. By the middle of June the locusts had grown so large that other means of catching had to be devised, while in the majority of cases the crops were either so badly injured as to be not worth fighting for, or were so far beyond the reach of the locusts that remained that further fighting was unnecessary. It is difficult to estimate the exact amount of success to be attributed to the different methods of destruction as they were applied, or indeed to any method that has been applied so far. In a warfare of this kind the farmer must take his chances, and what proves successful in one place, or in one year, may be totally futile at another time or place. In spite of all that has been said and written for the last three years it is necessary to say here once more what most of our farmers are at last convinced of, that in strong emergencies there is no dependence to be placed upon anything but a well dug and carefully tended ditch about the fields. If properly constructed it will prove, in nine cases out of ten, an absolute barrier until the locusts acquire wings, when the element of chance comes in again. Dr. J. C. Currier, of Mankato, managed with a ditch to save entirely unharmed the crop of 160 acres, in the midst of locusts hatching out in unusual numbers, and the method, the cost, and the result of the experiment will be found in full in the report of the National Entomological Commission; upon the Barden farm near Windom it is reported that a heavy crop was saved by a diligent use of tar-pans; Mr. Robert Lowe, of Lynn township, McLeod county, in a neighborhood where the locusts hatched in great numbers, managed to save part of a crop by using the tar-pan early in the season, and later on an open-mouthed trough, dragged over the grain after nightfall. Under the date of Nov. 21st, 1877, he writes:

"The field of wheat opposite my house yielded me 20 bushels to the acre,—the part of it which I saved, which was about 10 acres. The two neighbors of mine north of me did not fight the hoppers at all, and that part of the field next to them was eaten close. I kept working at them every night, but they got a part of it before they left.

On a three-acre field south of my house, the hoppers ate about one acre of it; they came from another neighbor that did not fight them. The two acres left yielded me 25 bushels to the acre.

The two neighbors north of me, above referred to, had about 25 acres of wheat each; one of them harvested 4 bushels to the acre, the other 3½ bushels.

I had 20 acres of new land and 5 acres of old land in wheat in another place. None of the neighbors around fought them and I did not get a kernel off that. The hoppers were more than I could handle there and on that I *did* save, so I confined my operations to that I saved. One neighbor near me who *did* fight the hoppers, saved 65 bushels from about 7 acres."

On the other hand there were fields that were swept clean of grain at the very outset. The only thing that could have saved such would have been a ditch constructed before the locusts began their march. To say that such a ditch would have proved insurmountable in every case would be to assume too much, but there is no question that it would have succeeded in a large number of cases where every other defence failed.

All this refers to protection against insects hatched outside of tne grain fields. There are also large extents of wheat sown upon newly broken prairie ("new-breaking,") where the eggs had been deposited in great abundance in 1876. Wherever the deposits had been left undisturbed, the growing wheat was destroyed at the outset. Even where the surface had been harrowed or broken with the seeder in the fall of 1876, the eggs left undestroyed were still numerous enough to consume the wheat as fast as it grew. Only plowing the eggs under deeply, or vigorous harrowing of the surface in the fall or spring, with the use of a tar-pan pan to catch such as hatched upon the field, together with a ditch to prevent incursions from without, might have sufficed to save such fields as these.

INJURY TO THE CROPS.

Nineteen counties are stated by the Honorable Commissioner of Statistics to have been more or less injured in 1877. These are as follows: Kandiyohi, Chippewa, Wright, Stearns, Nicollet, Pope, Douglas, Swift, Otter Tail, Stevens, Grant, Todd, Renville, Sibley. McLeod, Meeker, Yellow Medicine, Brown, Redwood. He adds: "The most careful estimates of the bushels harvested by the counties gives the following results:

Kandiyohi and Chippewa, total loss; Wright county, slightly injured; eight counties are believed to have saved half a crop; one, a third; one, a tenth; two, two-thirds; three, three-quarters; and one, four-fifths.

This was the Commissioner's estimate in October, and it is not probable that exact statistics will *add* anything to the estimated loss. Of the above counties three were probably more injured by the flying swarms than by the young. In addition to the counties named above, thirteen others were by the end of May in a state of more or less apprehension, and tar-pans were put to vigorous use. A hot, dry June like that of 1876 would have resulted not only in greater damage in the injured counties but would have added many other counties to the injured area.

The comparative temperature and rainfall for the last four years may be seen from the following table, derived from the reports of the Signal Service at St. Paul.

	Average Temperature.		Total Rain Fall in inches.		Number of days when rain fell.	
	May.	June.	May.	June.	May.	June.
1874	62.24	68.7	1.65	11.67	7	16
1875	58.81	63.6	3.06	4.33	12	17
1876	59.2	66.3	3.15	2.02	12	14
1877	62	63.7	5.43	7.13	12	13

The total rain-fall in May was considerably greater than in any of the three preceding years, while that of June was greater than for any year since 1874. The average temperatures for May and June do not differ greatly from other years, but a detailed table would show the result of weather much better than a table of averages. It would show a well distributed rain-fall, accompanied by cold days, with northeast winds. This was the character of nearly all the former half of June. The result of this in May was a more than usually prolonged hatching, as the rain coming just when the egg-pods were bursting arrested the hatching for a time, and no doubt prevented it altogether in soils that retained moisture. Eggs thus arrested were found in the latter part of May in a decayed condition, and a prey to the Anthomyia maggot. The last two weeks of May however were warm and dry, and this gave the young insects a full opportunity for destroying the grain where they were numerous. But the change of temperature early in June again arrested their progress wherever the grain had not already been badly cut off. The large number of damp, cold, and cloudy days deterred the locusts from eating, and gave the grain an opportunity to recover itself, while the temperature was exactly such as to produce the strongest and rankest growth of wheat foliage. As this sprang up apace and covered the ground, the locusts, loving warmth and sunlight could not spread through and over the fields as in a year of slender and sparse growth, while the abundance to be eaten necessarily left more which escaped untouched. In many cases the wheat in this way attained a growth which afterwards remained beyond the reach of the locust. In others the insects were abundant enough to trim off the foliage, and in the first week of July thousands of acres of wheat stood in the fields like bare spindles, the head still enclosed in the terminal leaves. Possibly a continuance of favorable weather through July would have produced something from even such fields as this, but, in the hot, dry weather which followed, the heads never filled.

But it is to favorable temperature more than all else that we are to assign not only the abundant harvest in the uninjured counties but such crops as were saved in the remainder. Those who believe that the efficacy of our prayers may be tested by the material results which follow them, can safely find a beneficent answer to the fasting and supplication of April, not in a brief snow storm that perhaps destroyed an insignificant number of locusts which would in all probability have proved harmless, but in a whole season of favoring winds and nourishing rains.

The effects of climate were seen too upon the young insects as well as upon the grain. It is to this doubtless that we are to assign the cause of the often reported disappearance of the young in the spring without committing injury, and of the harmlessness, "from causes unknown," of such as remained up to the time of flying; reports which come from Iowa oftener than from Minnesota. It is to the same cause no doubt that we are to attribute the number of locusts found dead in the fields during the spring; numbers which were very inconsiderable when compared with those which remained alive, but sufficient to show that unusual agencies were at

work. To those who from limited observation believe that the species is proof against moisture, it may be asserted that a spring of a different character from the four preceding has been followed by an unusual series of locust events, viz.: comparative harmlesness of the hatching brood, a partial degeneration, and finally a total migration as if from an unnatural neighborhood; while still others are to be reminded that the State is no more a permanent breeding ground of the species, and no more likely to be, than it was some years ago.

MOVEMENTS OF THE WINGED.

Here and there a fully winged individual of Spretus may be found in our fields early in June. I noticed such on the 8th of June, 1876, and on the 14th day of June, 1877, while others were reported as early as the 26th of May. From the middle of June the number of the winged increases rapidly, and these often rise in the air singly, and float lazily along on the breeze. On the 19th of June I observed such at Mankato, as thick in the air as stars upon a moderately starry night, while upon the ground below a still greater number had developed wings, and on being disturbed would start up for a low flight of a rod or two. Here and there one would rise from the earth, and could be seen rising very gradually in the air for a long distance, until it finally became lost to sight. Neither on the ground nor in the air was there any appearance of swarming. The numbers in the air increased rapidly from day to day until the last week in June, when, as if they had begun to mass their forces, dense swarms could be seen moving slowly, high in the air, over the central portion of the State. These, though appearing to move southeast on the 26th, 27th, and 28th of June, were not seen east of what had been the hatching area. From the latter date until nearly the middle of August the State was repeatedly crossed and recrossed by immense bodies of locusts, alighting heavily and destructively in the first week of July, but only appearing high in the air, and purely as migrating swarms later on. These movements consisted generally of bodies, (rather than of one immense swarm,) seen here and there over a large area, all pursuing one general direction, and following each other for a few days until the supply seemed exhausted, when, after a change of wind, what were apparently parts of the same army, returned over their former track only to be carried back again with others when the wind changed back again. As the season advanced, the swarms making up these armies became more scattered, and followed each other at wider intervals, or were soon separated at long distances from each other.

MIGRATIONS.

These movements may be briefly summed up as follows:

July 3d-7th—A movement to the northwest by daily journeys, with heavy alighting each evening from Willmar westward to the Sisseton Reservation and beyond.

July 8th–10th—A change of wind, with a return at once to the southeast. This movement was observed at sixty points between Bramble county, D. T., and Freeborn county on the south, and between Otter Tail and Sherburne counties on the north.

July 11th and 12th—A change of wind and return of the swarms to the northwest, observed at various places between Detroit and Sioux City on the west and between Sioux City and Fort Randall, D. T.

July 20th and 21st—An immense movement to the southeast again, observed at 78 points in Minnesota and Dakota. Swarms were seen on the western line of observation, at various points between Walhalla and Rockport, D. T., 375 miles from north to south, and between Rockport and Albert Lea, on the southern line, 225 miles from east to west.

July 28—Another movement to the southeast, seen over various northern and southern counties, but not reported over a large number of intermediate points.

August 1st and 2d—Another extensive movement to the southeast. This was seen at various points between Glyndon and Luverne on the west, and at St. Cloud, Anoka, Northfield and LeRoy on the east.

Aug. 6th–9th—Heavy flights, (but decreasing in numbers daily) to the southeast again; seen mostly on a line between Benson and Mankato and Worthington.

Sept. 2d—"Large numbers" flying southeast over Waseca.

Sept. 18th—"Millions seen flying in a southeasterly direction" at Long Prairie.

There is reason to believe that, as has been known elsewhere, many of these swarms continued their flights through the night. They were observed on several occasions flying till nearly sundown, while it was impossible to learn of their alighting anywhere at or during the night; they were seen moving early in the morning as soon as the sun was high enough to make their numbers visible, while there was no known starting place from which such swarms could have proceeded so early in the morning; and in one known case, (and probably in many others,) they abandoned in the night a spot where they had been abundant during the day.

It will be noticed that after the 20th of July all extensive movements were to the southward. On the dates intermediate between those given, there was a change of wind to southward, and this carried back sometimes considerable, but always scattered bodies to the northwest, while as the season advanced the number thus carried back became fewer. Those which were carried to the northwest probably helped to make up the bodies which moved southeast again as soon as the wind changed to northerly, and what may have been something like a compact army early in July were spread over a large territory later on. The change of wind between the 7th and 8th, and again between the 10th and 11th of July were followed at once by the return of swarms over the track where they had passed the day before; on the other hand it required a change of wind from the 12th to the 20th and again from the 20th to the 28th

of July to collect and bring back the swarms which passed over on the latter dates. During the later movements too, straggling bands were seen at a considerable distance to the east of the main bodies, as at St. Paul on the 20th of July, on the 1st and 2d of August at Anoka, St. Paul, Northfield and Leroy, on the 6th of August at Hastings, Dundas, and Brownsdale; and during August and September over El Paso, Wisconsin, and over Osage, Grundy Centre, Toledo, and Montezuma, aud perhaps over Waverly, Waterloo, Oskaloosa, and Vinton, Iowa, all of which points lie considerably to the east of the usual locust area.

All the movements after the 10th of July were purely migrations. Here and there individuals dropped down from the passing swarms until a township or two was pretty well covered, but as a rule the insects passed over without alighting. To determine the migratory capabilities and habits of the locust would be interesting and useful. During the summer I collected nearly a thousand reports, diaries, &c., to learn the extent of the flights over Minnesota. The impossibility of obtaining similar reports from Central Dakota, and the absence of such from Iowa, render it difficult to trace movements beyond the State line. The turning point of flights between the 7th and 8th of July was evidently in the neighborhood of the Sisseton Reservation; between the 10th and 11th, either in or over Iowa; about the 22d of the month the swarms collected in Dakota along the route between Bismarck and the Black Hills and these were perhaps brought southeast again on the 28th of July.

It seems probable that most of the swarms seen passed to the southward of Minnesota and remained there. It is certain that the bodies composing the different migrating armies became widely separated from each other during the season, and it is highly probable that the individuals composing these bodies were distributed over a large extent of territory and often so sparsely as to remain almost unnoticed. By the first of September the species was found at Sioux City and Fort Dodge, Iowa, in small numbers, but more numerous than the native species; still more numerous at Ackley, where they were preparing to lay; again in very small numbers at two or three stopping places along the road between Ackley and Lyle, at Lyle and at Austin; and a few days later at Lake Phalen, five miles northeast of St. Paul. It is very likely that a careful search in 1878 by those acquainted with the species will disclose the presence of the young in very small numbers at various places in Eastern Minnesota, in Wisconsin east of Hastings, and in Eastern Iowa.

The locust evil being ended for the present, all further consideration of the matter produces in the mind of the farmer only that disgust which is excited by an unpleasant subject. But the time will come again when the possibility or likelihood of locust invasions, and whether they can be anticipated or prevented will be questions of immediate interest. But to a community looking forward to years of prosperous wheat-raising, and knowing that future success depends in some measure upon exemption from various insect plagues, it should seem foolish to conclude the inquiry with that amount of knowledge which has so far been obtained. The National Entomological Commission should be enabled to

pursue its investigations beyond the field where circumstances have so far confined them, into the region where the nature of the locust problem is still largely unknown, and where alone the possibilities and probabilities of future destructive incursions are to be calculated.

DISTRIBUTION.

A history of former locust invasions, and a full chronology of locust appearances in past years, whether seen in small or in great numbers, in destructive onslaughts upon the grain, or in harmless migrations to other neighborhoods, become valuable to assist in determining what are the regions of perpetual, frequent, or occasional presence. It has been common to call "locust years" only those years in which swarms have appeared in destructive numbers, and to call "locust regions" and "grasshopper counties" those only where cultivation has been sufficient to invite injury. It has often been difficult to collect such facts as there are, and the desire to appear well in immigration statistics induces men to withhold occurrences that would seem to convert their particular localities into "grasshopper regions" for the time being, but which were after all only trifling appearances of a misfortune that was felt elsewhere in full force. "Locust regions" are not created by simple statements of facts, nor are the gardens of the world depopulated by occasional locust invasions.

But a locust chronology for the past fifteen years contradicts the notion that there is anything like periodicity in the appearance of the species, though there are evidently years or periods of excessive multiplication; it also disposes of such vagaries as that the stock has been advancing eastward yearly, occupying a certain belt of country each year; or that they "move mostly in a great circle, touching Missouri on the east, and New Mexico on the south, the Pacific on the west, and far into the British Possessions on the north," the time required for swinging around this circle "being about ten years, though some get behind by being hatched out late!" It has been a locust year somewhere or other nearly every year for the last fifteen years, and swarms have repeatedly swept southward from British America perhaps to Texas, while their offspring moved back northward over the same track in the following spring. It would seem that east of what may be the permanent breeding grounds of the species, there is a region where swarms appear nearly every year, and that the permanence or frequency of appearance diminishes as we move eastward. To say that this region of frequent appearance is not a "grasshopper country," is to say for the present that it is mostly uncultivated and uninhabited, though there is no reason to believe that if it were under full cultivation that it would suffer devastation every year.

This region of frequent appearance reaches eastward nearly to Minnesota, and the frequency results from the fact that the region referred to lies in the track of swarms moving northwestward towards the mountains in the spring, southeastward from the mountains in the summer, and at the same time in the vicinity of swarms occasionally hatched upon the plains. At least it is certain

that the locust has been seen either along or east of the western border of Minnesota nearly every year since 1863. At Walhalla, a few miles west of Pembina, they are said to have come one year and left in the year following ever since in the year just named; in the same year (1863,) they were about Moorhead, around the Coteau des Prairie, Ft. Abercrombie, and were seen flying as far east as the Pomme de Terre River; in 1864 the young hatched near Moorhead, and possibly in other places in the western part of the State north of the Minnesota river; while in July winged swarms from the west made their way in a narrow column up the Mississippi Valley to Le Sueur and Henderson; in 1865 the young of these were troublesome in the regions just named; in 1866, a year of serious invasion in States to the southward, there were but slight and transient appearances ot swarms in Minnesota, about Moorhead, and in Redwood and Kandiyohi counties; in 1867, a year in which Iowa was overrun almost as extensively as in 1876, there was no appearance in Minnesota so far as can be ascertained; in 1868 large swarms passed northward over Jackson county for two or three days, probably those which had hatched in Iowa and the States below; in 1869 the insects were seen about Moorhead again; in 1870 about Moorhead and in Brooking Co., D. T.; in 1871 a large number of our northwestern counties were visited, but were injured only here and there; in 1872 the offspring of these augmented by others hatched in Dakota seemed to have passed southward in immense armies over Southeastern Dakota and Nebraska; the events since 1872 are too well known to need repeating.

There is nothing alarming in these statements; it is known well enough in how few of all these years the insects have poured into the State in immense swarms, and how few of all the swarms that have appeared have remained to prove destructive. It is only in a year of excessive and repeated visitation that the small numbers remaining behind from each passing cloud finally become numerous enough in the aggregate to make their presence destructive in the year following. It is only meant to show that Eastern Dakota lies in or near a region where the locust frequently appears; somewhere within yearly reaching distance of the transient or permanent breeding grounds of the locusts. On the other hand but a few miles to the east lies a region where the locust appears but rarely, while still a short distance beyond is a region where it never appears.

A line drawn from Crookston to Le Sueur, thence southward across Iowa through Fort Dodge marks nearly the general eastern limit of serious injury. In Minnesota this is nearly the dividing line between the prairie and the timber, which in Douglas and Otter Tail counties extends some thirty miles to the west of the line though not densely everywhere. From Le Sueur southward the line again coincides very nearly with the western boundary of the Big Woods, until the latter, thinning out give place to the prairie counties of Southern Minnesota and Iowa, where as the physical barriers of the forest no longer exists, the line must represent nearly the natural limits of the encroachment of the species. That there is some such natural eastern limit, coinciding nearly with the line

given, is seen from the fact that the hatching swarms, on migrating, have on no occasion whatever occupied new ground to the eastward, or pursued any line of flight which would not carry them somewhere to the west of where they hatched. Whenever invasions have been carried to the east of the usual line, it has been in all cases by swarms appearing from the northwest, generally late in the season and by slow advance.

These in exceptional cases have occasioned injury or have deposited eggs in the openings to the east of the limits named, but with serious results only in 1856 in the Upper Mississippi Valley, and in Todd and Stearns counties in 1876.

To determine exactly how far east the species has hatched of late years, and to say just where it definitely ended, would have required careful examination by those acquainted with the species. It hatched in 1877 in observable numbers at least fully up to the line given upon the "Map of Locust Areas," in the report of the Geological and Natural History Survey for 1876. The hatching of the year confirmed the general correctness of this line; still more correctly it might have been drawn from Detroit to Princeton, thence southward to Austin, whence it moved southward across Iowa, passing nearly through Hardin, Story, Dallas, Madison, Adams and Taylor counties. But throughout all the eastern portion of this hatching area the young appeared in squads on scattered hatching grounds, and no doubt careful search might have found still others east of the limits given, the young of the swarms straggling eastward late in the fall, and finally disappearing, no one knew where.

It would be interesting to learn also the extreme northeastern limit of the appearance of the species. It lies somewhere in a region of woods and swamps north of the Northern Pacific and east of the longitude of Brainerd. This almost uninhabited region, though not lying in the usual line of flights, might be traversed by swarms in almost any summer and the fact remain unheard of. It is certain that locusts in years past have been seen in swarms, or in small numbers on the ground, at Red Lake, Leech Lake, Gull Lake, Brainerd, Aitken and Duluth, while several years ago locusts injured the vegetables and grass upon the island opposite Ashland, Wisconsin. All these points lie in a region which the locust is supposed to avoid. But even if it is possible for this insect to choose by instinct a certain line of flight, and to select the winds which will carry it in that general direction, it is carried at times to situations which the most trifling amount of instinct would cause it to shun, and has been found in immense numbers in the waters of Lake of the Woods, Red Lake, and in fewer numbers in Lake Superior. The northeastern limit of flight depends, partly at least, upon the point where swarms cross our border, and those coming in well to the east on the Manitoba line might, as in 1856, be carried into the Upper Mississippi Valley. The swarms of that year were no straggling bands, blown out of their course late in the season, but came in immense numbers, which by the testimony of all who remember the event, were many times more numerous than any that have appeared in later years. These reached Gull Lake and the region around it near the end of July, and not only destroyed the

crops at Crow Wing and thence southward in the Upper Mississippi Valley (which has never since been injured between Crow Wing and Sauk Rapids.) but penetrated in monstrous numbers into the woods about Mille Lacs Lake where they bent down the pine branches with their weight. They penetrated in considerable numbers as far as Cambridge, Isanti Co., a point which was hardly reached by swarms of 1874, and was not visited in 1876. All those swarms of 1856 must have crossed the northern boundary well to the east, or must have turned their flight eastward over the very regions which the locust is supposed to avoid. It is also noticeable that they penetrated southward only to about the neighborhood of Shakopee.

This was an exceptional instance in some respects. and in the locust invasions which we are destined to suffer in the future, there will probably be occasional events which will seem to contradict all previous experience, and to make it impossible to lay down anything like general rules. It might happen that swarms in a long, warm, and dry autumn might pass a few miles farther east than they have ever appeared before, and leave eggs which in a following spring of excessive dryness, and with a thin growth of grain, would prove destructive to a large proportion of everything sown. For all that the species has a certain natural range, and though no line can be definitely drawn beyond which it can be predicted that the locust will never appear, the regions of habitual, frequent, and infrequent appearance will be ascertained, while there still remains the strong probability that with increase of cultivated acreage towards the mountain regions the appearance of swarms in Minnesota will become rarer than before. It may even become possible to predict the time of appearance at certain points, and to take an example, as swarms reached Sauk Rapids about Aug. 20th, 1856, Aug. 17th, 1874, and Aug. 11th and 18th, 1876; as they reached Monticello Aug. 13th to 16th, 1856, Aug. 17th, 1874, and Aug. 18th, 1876, it is not probable that they will often reach the Upper Mississippi before the middle of August, or will often prove destructive to any great distance beyond it, either in a summer of invasion or in the spring following.

Finally, if there is in future any fear that Minnesota may become a permanent breeding ground of the locust, it may be said that so far as is known there is no permanent breeding ground of the species in any strict sense of that term. The species is migratory, and until it loses this habit there is no fear that the swarm which hatch here will remain to breed by natural increase. They may remove but partially, or to a short distance only, or they may be replaced by others in the same season, but in any case the instinct, the impulse, or the chance wind which brings them upon us will eventually remove their offspring.

The reference on the 2d page of this report to damage inflicted by the Chinch Bug may be found on pp. 17 and 18 of the Report of the Commissioner of Statistics for 1877, as follows:

"The crop of 1876 was menaced by three destructive agencies. The one already mentioned—heat drouth or whatever it was; the dreadful locust, whose flickering wings filled the air in the western portions of the state from the earth to the highest point of human vision; and locally, in Houston county, the chinch bug, where considerable damage was inflicted by this new foe to our great staple.

* * * * * * the third was not of sufficient magnitude to warrant the precise ascertainment of it—but it is a dangerous and insidious foe, and doubly dangerous because it is insidious, and should the coming year be marked with their renewed attacks, they should be carefully studied and their characteristics reported."

Upon page 97 of the same report the Commissioner quoted the following letter:

CALEDONIA, HOUSTON CO, MINN.
December 10, 1877.

T. M. Metcalf, Commissioner of Statistics:

SIR:—In reply to your inquiries as to the ravages of the Chinch Bug in this county, I cannot say much.

These pests are a mystery to me, and to every one of whom I have inquired, and I have not been able to find out much about them.

They are here now; they have charged the earth with eggs ready for the hatching temperature of earliest Spring, when, I fear, our farmers here will catch it again. I learn that they are at Fountain, on the Southern Minnesota Railroad, in myriads.

It is estimated that they destroyed two-fifths of the wheat crop of this county in 1877.

The *bee theory* has been tried on them. They smell like a bed-bug, and one can detect their presence by the smell in walking through the fields. They also manifest themselves by the change in the color of the grain. Their season is when the grain is in the "milk," just before harvest.

They do no injury at all before that time.

It is said that they were here before—just at the close of the war. Some of them live in the ground, under the stools of the grain through the winter, but most of them leave their eggs and die in the fall.

They work in a small patch, and all that are in that patch get together at night in a large pile, like ants in a hill, and the boot-heel, and hot water, with aid of lanterns, are used; but this is a slow process. When they finish a small patch, they move to another part of the field.

They were not troublesome in the western part of this county, nor were there many, if any, in adjoining counties.

Very Respectfully,
Yours, &c.,
E. W. TRASK,
Auditor of Houston Co,

I have received the following letter from the same source :

Dear Sir:—Your favor of the 19th inst. requesting information concerning chinch bugs, rye, &c, came duly. The chinch bugs promise mischief again this year in this county. They are very thick in the fields. We are a little in hopes that frequent cool showers will keep them back, and the early season ripen the grain before they do much damage. Some, not much, winter-rye is sown. The bugs do not trouble that much I am informed.

Respectfully,
E. W. TRASK,
Auditor of Houston Co.

Caledonia, Minn. May 22, 1878.

Crop reports in the St Paul Pioneer Press during the past month mention the presence of the chinch bug in other localities. As it may be necessary for farmers to take what precautions they can against this most dangerons insect, I here briefly digest the substance of several entomological reports upon the chinch bug, with the hope that the republication of these notes in the newspapers may add something to the knowledge of those who are not practically acquainted with it. Riley's Seventh Annual Report for the State of Missouri (pp. 19-50) describes (with figures) the insect in full, its habits natural enemies, and the best methods of contending with it. Fitch's 2d Entomological Report for the State of New York. Harris, Insects injurious to Vegetation, and Prof A. S. Packard's Report on the Locust and other Insects in the western States and Territories contain interesting and valuable information on the same subjects.

THE CHINCH BUG.

Mentioned in various agricultural and entomological reports under the scientific names of *Lygaeus Leucopterus*, *Rhyparochromus Leucopterus*, *Micropus Leucopterus*, *Blissus Leucopterus*.

An hemipterous (half-winged) insect of the sub-order of *Heteroptera;* emitting, like many insects to which it is related, and for some of which it is easily mistaken, a nauseous (bed-buggy) odor.

A sucking (haustellate) insect, furnished with a sharp-pointed beak, subsisting upon the juices of grasses and cereals. Found while young feeding upon the roots and afterwards upon stalks and leaves.

The adult insect is about three-twentieths of an inch in length; the body is long, blackish, and hairy; the wings and fore wings are white, while the latter have a black spot upon the middle of the edge; legs dark yellow. Some ten varieties (including one wingless) are found differing more or less in color, but in general the species may be easily distinguished by the white fore wings with the black spot upon the edge.

The adult insects pass the winter hidden about the edges of fields, "under dead leaves, under sticks of wood, under flat stones, in moss, in bunches of old dead grass, or weeds or straw, and often in cornstalks and cornshucks.—*Riley*.

These come forth in the warm spring, pair, and the female deposits her eggs, laying them from day to day for about twenty days, underground upon the roots of the plant destined for food. These are laid in clusters, and are about three one-hundredths of an inch long, and pale amber-colored. They hatch in about two weeks, and the wingless young, bright red in color, may be found around and clinging to the roots where they have been hatched. These acquire wings in about six weeks, and after pairing, produce a second brood which lives through the winter, as stated above.

The insects may be seen upon the wing at pairing time, but do not take to flight readily. Their migrations are performed mostly on foot, in the growing stages, and from one field to another.

For the purpose of destroying the adult insects in the fall and winter, and to prevent future multiplication, the corn-stalks, dry weeds, rubbish, &c., about the fields, should be burned, or these with boards, or anything under which the insects may take shelter, may be left around the fields, for the purpose of trapping them.

As the female endeavors to penetrate below the surface of the ground for the pupose of depositing her eggs about the roots of plants, rolling after seeding tends, by hardening the ground, to prevent the deposit of eggs.

Early sowing and invigorating the plant with manure tend to bring forward the crops before the young are capable of doing their greatest injury.

As Hungarian grass is a favorite food of the chinch bug, a rod or two of it sown around a field of wheat tend to keep the young occupied until the wheat is out of danger. It is also recommended to sow with each 12 bushels of winter wheat one bushel of winter rye, as the bugs will destroy the rye in preference to the wheat; or to surround or intersperse grain crops with hemp, flax, castor beans, or buckwheat. Whenever badly infested patches of grain are noticed early in the season, straw should be spread over them and burned.

The migrations of the young, on foot, are prevented by boards set on edge along fields, and smeared with tar; or by coal tar poured along on the ground; or by running along the edge of fields a furrow turned outward, in which the insects may be destroyed by dragging, burning, or in pit-holes.

Excessive moisture, (rain, etc.) are destructive to the chinch bug; hence wherever continued irrigation is possible the insects may always be destroyed while still underground.

Among the natural enemies of the chinch bug are several species of Lady Bird, the Insidious Flower Bug, and the many-Banded Robber, (of insects), and the quail, as well as (perhaps) the prairie-chicken and red-winged black-bird.

As before stated, many insects closely related to the chinch bug, having nearly the same form and smell, may be easily mistaken for it. Perhaps the most common of these is the False Chinch Bug (Nysius Destructor). [I found these in abundance (pairing) around Monticello, June 14, in cornstubble and around purslane; they were mistaken for the chinch bug by those who had seen the latter repeatedly].

The chinch bug is a southern rather than a northern species of insect, but it has been found in Wisconsin considerably farther north than in Minnesota, and Prof Packard has found it in Maine and on the summit of Mount Washington. He infers that it is found in the colder as well as warmer portions of New England, and adds. "It probably inhabits the entire United States east of longitude 100°, and will probably occur in the western Territories, wherever wheat is raised, though perhaps the altitude and peculiar climatic features of the Rocky Mountain Plateau may prevent its rapid and undue increase."

It has years of excessive multiplication, like the locust, and other insects. In 1864 it was exceedingly destructive in the Mississippi Valley. In 1868 it did considerable damage in Southern Illinois and Southwestern Missouri. In 1871 and 1874 it was again very destructive—in the former year the losses were estimated at thirty, and in the latter at sixty million dollars, the losses in Missouri alone amounting to ninteen millions. (Riley). In such years as these its control passes beyond the hands of man, and it is only possible to mitigate its ravages to some extent, by earnest and united efforts.

Respectfully submitted,

ALLEN WHITMAN.

XI.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell:

DEAR SIR :—In accordance with your request I have the pleasure to report a satisfactory advancement of the ornithological survey of the State during the past year. Personally, and through the assistance of competent observers, representative localities remote from the settlements have received special attention, particularly those embracing water-courses, and heavily timbered districts. Many important facts pertaining to the migration, distribution, feeding, and breeding of some species about which hitherto very little has been known, have been obtained which will be valuable in the further prosecution of the survey. Another of these facts, notably, is the intermixture of varietal forms representing different avi-faunal provinces. The western borders of the State have long been known to be interchangeable grounds, but it appears that most other portions partake of the same characteristics. I merely allude to these things to indicate to you some features of the work to be accomplished. If it were only the listing of species found to be what is commonly called *resident birds*, my previous work, together with my co-laborers in the Minnesota Academy of Natural Sciences, would leave comparatively little to be done. But it embraces the largest measure of attainable data in everything pertaining to the esthetic and economic relationships of the birds to the commonwealth.

To accomplish so much, or to approximate it necessitates the employment of all available aid and considerable time. I regard myself highly favored in having the co-operation of several competent collectors in the different sections of the State and especially a number of young men residing in this city. They have already contributed notes on the habits of some rare species that are of

great value which will appear in my final report, when each will be duly accredited with all that he has done.

With this abbreviated general statement of what I have accomplished during the year, reserving details for a final report, I remain

Yours respectfully,

P. L. HATCH.

818 Nicollet Avenue, Minneapolis, May 1, 1878.

XII.

RAILROAD ELEVATIONS.

BY E. S. ALEXANDER.

ELEVATION on the Hutchinson branch of the Minneapolis and Northwestern Railway—Commencing 11.6 miles west of Minneapolis, on the line of M. & St. L. Railway, thence westward through counties of Hennepin, Carver and McLeod, to Hutchinson—from notes of preliminary survey made in November, 1877.

Miles from St. P.&P. Ry Depot.		Elevation above Ocean.
11.6	Island Lake (M. & St. L. railway track)	893
	" " (surface of water)	881
12.2		903
13.4	Town-line between Eden Prairie and Minnetonka townships 1¼ miles east of northwest corner of E. P. township (ground)	842
	Bottom of Purgatory creek	838
15.6	Town-line, Minnetonka and Excelsior townships, ¼ mile north of township corner (ground)	881
15.8	Opposite north end of Silvine or German Lake (water—about)	881
16.9	Summit of ridge between Silvine and Christmas lakes	978
17.1	Ridge south of Christmas Lake	997
	Christmas Lake (water—about)	920
18.2	Lake Lucy (ground)	945
	" " (water)	943
19.3	On west line of section 3 near ¼ corner Chanhassan township. This is on a narrow ridge 15 feet above the tamarack swamp on west, and 20 feet above tamarack swamp on east; the hills on each side are sixty or seventy feet higher than the swamp	989
20.0	Minnewashta Lake (water)	934
20.7	North line of Chanhassen township, in front of school house No. 59	972
21.8	Virginia Lake (water)	919
22.7	Outlet of Virginia Lake—head of Lake Minnetonka—old site of Smithtown (water of Minnetonka)	917
	From here the line follows around the south side of Lake Minnetonka and Halsted's bay to 26.2 miles. Bluffs are from 80 to 100ft. high.	

Miles from St. P.&P. Depot.		Elevation above Ocean.
26.5	Ridge between Six-mile creek and Halsted's bay	943
26.6	Marsh of Six-mile creek	919
26.7	Six-Mile creek (bottom)	913
28.8	500 feet north of the center of section 20, Minnetrista township—outlet of large cranberry marsh	973
29.2	Watershed between Lake Minnetonka and Crow river	981
31.3 to 32.2	On south edge of Picture or Mud Lake (water)	929
32.2	Center of section 14, Watertown township	931
33.3		983
35.1	Crow River (bluff on east side)	965
35.8	" " (Watertown mill-dam)	916
	" " (bottom of river)	910
36.7	1,900 feet north of southwest corner of section 8, Watertown Tp., (grassy swamp)	926
39.9		961
43.0	Ocean Marsh (grassy marsh)	988
43.9	County-line between Carver county and McLeod	1,014
44.4	Outlet of Winsted Lake [dry bottom]	981
44.6	Winsted Lake, south side [top of bluff]	1,003
	" " [water]	985
46.9		1,026
48.7		1,029
49.7		1,048
52.0		1,040
54.0	1,400 feet west of the southeast corner of section 28 in Hale township—half mile north of Silver Lake post-office	1,051
55.3		1,074
56.0	Swan Lake [water]	1,036
56.4		1,066
57.5	Bear creek	1,037
58.6	Leave Big Woods and enter the rolling prairie	1,058
61.7	Crow River [bluff]	1,068
62.1	" " [water]	1,020
	" " [bottom]	1,017
62.4	Hutchinson	1,033

The above levels do not give a correct idea of the nature of the country—which is very rough as far as Watertown.

From 12.5 miles to 15.8 miles the line follows the valley of Purgatory Creek, whose bluffs roll back to a height of about 70 feet in quarter of a mile.

At 17.0 miles the line crosses a ridge which runs northeasterly and southwesterly. This ridge, compressed to a width at the base of 500 or 600 feet between lakes Silvine and Christmas, widens out both southwest and northeast. It prevents Lake Minnetonka from draining into Purgatory creek—although that valley is nearly forty feet lower than the lake—and flowing thence into the Minnesota river.

The bluffs on Lake Minnetonka rise abruptly to hight of about 80 feet, and a few hundred feet back are 100 feet above the lake. The line runs around on the foot of the bluffs.

From Six Mile creek the line follows up a small valley to 29.2 miles where it crosses the watershed. At this place there are hills on each side which must be 80 feet higher.

From here it follows down a small ravine between high hills to Picture Lake. On the north, south, and northeast sides of this lake the hills rise abruptly about one hundred feet.

From here to Watertown the country is not so broken.

From 36.5 miles the line follows up a small valley—whose bluffs are about 40 feet high—to 39.9 miles.

From this point to Hutchinson the general level of the country is very well shown by the table. It is rich and rolling, the knolls rise ten, twenty, and sometimes thirty feet above the depressions.

[The red hardpan drift, in a modified condition, extends *via* Hopkins Station, past the east end of Lake Minnetonka, and to within perhaps five or six miles of Excelsior. The drift knolls that seem to extend in a nearly continuous series along the south side of the Lake Minnetonka consist of this red drift. There are occasional places of sandy surface, and others of red loam, but the most of the surface is of a red gravelly loam that seems to be derived from a slight mixing of the gravelly sub-soil with a thin loam that probably corresponds to the loess loam of further east. On these knolls the soil is the same, but is much thinner, or almost destitute of loam.

On the road to Wayzata, from Minneapolis, the red drift continues to the Half-way House about seven miles from Minneapolis. Thence westward, along the north side of Lake Minnetonka, the surface is one of gray hardpan. N. H. W.]

XIII.

REPORT ON THE GENERAL MUSEUM,

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR THE YEAR 1877.

By N. H. Winchell, Curator.

The principal work during the year has been the opening, cataloguing, and placing on exhibition of the Kunz collection of minerals. On the completion of the twelve cases designed for minerals and fossils, which are constructed on the plan of similar cases in the Smithsonian Institution at Washington, these specimens were deposited therein. They were subsequently re-handled and neatly labeled with a form of printed label. In the same cases have been placed a part of the fossils of the Trenton formation which have been studied. The duplicates of the species of the Kunz collection, which constitute nearly one-half of its bulk, have also been examined, recorded in the register, and re-boxed. They will shortly be offered for exchange, and in that way will serve to increase the number of species in the Museum.

The *Megatherium* skeleton, a part of the collection purchased of H. A. Ward several years ago, was unboxed for the first time since its delivery at the University, in the summer of 1877, and carried to the north room of the Museum preparatory to mounting. Unavoidable circumstances, much to be regretted, have delayed this to the present, and the room, on the floor of which it is spread out, has necessarily been closed to promiscuous admission of the public, though interested visitors have been admitted on application.

Two other upright cases have also been built in the north room, uniform with those reported last year, designed for the exhibition of birds, thus furnishing the walls of the room with all the cases they will accommodate. In one of these cases Mr. Herrick has placed a number of our native birds, tastefully and naturally

mounted, and arranged on artificial supports. The ornithological observations of Mr. Herrick during the year have been reported to Dr. Hatch, for use in preparing a final report on the ornithology of the State.

In addition to the birds added to the Museum, a number of plant-specimens have been preserved by Mr. Herrick; and others have been presented by Mr. B. Juni.

The fossils collected from the Trenton limestone at Minneapolis are mostly entered in the Register, though as yet unstudied.

A collection of marine specimens from the coast of Virginia was presented by Ex-Governor Horace Austin, comprising the following species:

1.	Flying Gurnard. *Perinothus* (sp?)	1 specimen.
2.	Weak Fish. *Otolithus regalis. Cuv. and Val.*	1 specimen.
3.	Toad Fish. *Batrachus tau. Linn*	1 specimen.
4.	Perch. *Perca* (sp?)	3 specimens.
5.	Fiddler crab. *Gelasimus vocans. Milne Ed*	1 specimen.
6.	Crap. *Lupa* (sp?)	5 specimens.
7.	*Brachyuran crustaceans*	3 specimens.
8.	Sea Urchin. *Echinus* (sp?)	2 specimens.
9.	Brittle Star. *Ophiura* (sp?)	1 specimen.
10.	Star Fish. *Asterias* (sp?)	2 specimens.

These have been placed in suitable bottles in alcohol, and form, together with other specimens collected in the Custer Expedition to the Black Hills in 1874, and others preserved last year, the nucleus of a collection of the invertebrate and lower vertebrate animals which will be of much interest.

A specimen of the so-called Jack Rabbit was obtained at Lake Shetek in Murray county, where was also found the common eastern species. This is probably nearly on the eastern limit of the range of the Jack Rabbit. A few skulls are mounted on suitable pedestals, viz.: *Ovis*, *Canis*, and *Felis*, to which others will be added.

The following catalogue shows the name, number, and source of the geological and mineralogical specimens added during the year, exclusive of the collection of several boxes in the prosecution of the field work of the Geological Survey, and only so far as the same have been examined and labeled.

CATALOGUE OF SPECIMENS REGISTERED
in the General Museum in 1877.

Serial Number.	Obtained. When.	Obtained. Whence.	NAmE.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
90	....	Dr. Stoneman.....	Asaphus extans. H. Compare 399..........	1	....	Trenton...	Has tuberculated surface instead of lamellose.
172	Oct. 1872	Geol. Sur..........	Block with schizocrinus nodosus. H. Murchisonia. sp. ? and the head of a trilobite....	1	Pleasant Grove, Olm Co.	" ..	N. H. Winchell.................
185	1875.	"	Slabs containing Strophomena. (Specimens. Orthis Chetætes *et al*..........	1	Fillmore Co.............	" ..	" ....
186	"	"	Orthis perveta. Con. (Larger than the type.	4	Fount'n in Fillmore Co.	" ..	" (Taylor's Quarry)
189	"	"	Fragments of Asaphus gigas. H..............	1	Fillmore County........	" ..	N. H. Winchell.................
191	"	"	Slab with Leptaena sericea. Sow. Orthis emacerata. H. Strophomena filitexta. H. Strophomena nitens. Bill..................	1	" "	" ..	" ....
192	"	"	Slab with Poteriterinites caduceus. H. Orthis testudinaria. Dal. Rhynchonella capax. Con. Chaetetes Lycoperdon. H. Leptæna sericea. Sow.....................	1	" "	" ..	" (The Potteriocrinus-Dendocrinus C. according to Miller.
194	"	"	Part of buckler of Asaphus gigas...............	1	" "	" ..	N. H. Winchell.................
197	"	"	Orthoceras laquatum. H. ?....................	1	Spring Valley...	" ..	" (Com. 214.)......
208	"	"	Strophomena tenuistriata. (?)...........	1	Sec. 17, Roch't'r, Olm Co.	Galena....	M. W. Harrington, (Garirick's quarry,) Compare 311, 204.)
214	"	P. W. Thayer, Geol. Survey....	Orthis testudinaria. Dal. Murchisonia bicincta. H. Orthoceras laqueatum. H. Leptæna sericea. Sow. Bellerophon bilobatus. Sow. Strophomena nitens. Bill. Rhynchonella capax. Con..................	1	Spring Valley, Fill. Co.	Trenton...	N. H. Winchell.................
228	Oct. 1875	Geol. Sur..........	Leptæna serica.Sow...........................	1	Fillmore Co............	" ..	" ....

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
242	Oct. 1875.	Geo. Sur.	Cyrtoceras arcuatum. Hall	2	Holden, Goodhue Co.	Trenton	N. H. Winchell
243	"	" "	Oncoceras constrictum. Hall	1	" "	"	"
244	"	" "	Asaphus gigas. H. (Left maxillary portion, or cheek.)	1	" "	"	"
245	"	" "	Fragments of Asaphus gigas. Hall	3	" "	"	"
252	July, 1875	" "	Orthoceras vertebrale. Hall	1	" "	"	"
254	Oct. 1875	" "	Receptaculites	1	Lime City, Fillmore Co.	"	"
258	"	" "	Cyrtoceras ? sp. ?	3	" "	"	"
264	Sept. 1875	" "	Slabs with Strophemena and Orthis	2	Olmsted Co.	"	"
269	"	" "	Orthis subquadrata. Hall	1	Sec. 30, Forestville Fill	"	"
279	Oct. 1875	" "	Orthis. n. sp.	1	Minneapolis. [more Co.	"	" Same as 648, 346.
293	Sept. 1875	" "	Strophomena fluctuosa. Bill	1	Mantorville, Dodge Co.	Galena	M. W. Harrington, (Upper layers Wilson's quarry.)
294	"	" "	Graptolithus scalaris. Linn	1	" "	"	M. W. Harrington, (Upper layers Wilson's quarry.)
295	"	" "	Graptolithus. ?	1	" "	"	M. W. Harrington, (Upper layers Wilson's quarry.)
296	"	" "	Discina Pelopea. Bill. (263.)	1	" " [more Co.	"	M. W. Harrington, (Upper layers Wilson's quarry.)
307	Oct. 1875	" "	Chætetes petropolitanus, Pander ?	1	Sec. 21, Forestville, Fill-	Trenton	N. H. Winchell
321	"	" "	Orthis. n. sp.	2	Minneapolis	"	"
322	"	" "	Orthis perveta. Con	1	"	"	" Different form.
323	"	" "	Rhynchonella capax. Con	3	"	"	" " "
324	"	" "	" " "	5	"	"	" " "
325	"	" "	" " "	2	"	"	" " "
326	"	" "	" " "	1	"	"	" " "
327	"	" "	Orthis emacerata. H. var. multisecta. James.	1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
328	Oct. 1875.	Geol. Sur.	Rhynchonella capax. Con. (v. 220).	1	Minneapolis	Trenton	N. H. Winchell, Different form.
331	1873	" "	" " "	6	Minneap'lis, Finn's Glen	"	" Different form.
334	"	" "	Crinoid joints—(Schizocrinus nodusus H.).	4	" " "	"	"
335	"	" "	Crytolites compressus, Con.	1	" " "	"	"
336	"	" "	Orthis, n. sp.	1	" " "	"	"
339	1872	" "	Orthis, n. sp.	4 s'bs	Rochester, Olmsted Co.	"	N. H. Winchell—Whitcomb's Quarry, same as 346, 279, 648.
346	"	" "	Orthis, n. sp.	3	" " "	"	N. H. Winchell, same as 279, 648.
347	"	" "	Schizocrinus nodosus. H. (Stem).	1	Sec. 16, Pleasant Grove.	"	"
348	"	" "	Cyrtolites compressus. Con.	1	" " "	"	"
350	"	" "	Orthoceras strigatum. H.	1	" " "	"	"
351	"	" "	Slab containing chætetes Lycoperdon. H.	1	Pettit's Mill.	"	"
352	"	" "	Oncoceras constrictum. H.	1	Pleasant Grove.	"	"
356	"	" "	Strophomena. (sp. undistinguishable).	1	" "	"	"
371	"	" "	" (tennistriata? v. No. 204 and 208.	1	Nr Rochester, Olmst'd Co	Galena.	" This shell is also found at Mantorville.
374	"	" "	Orthis.	12	St. Charles.	Trenton.	"
376	"	" "	Asaphus gigas. H.	1	"	"	"
379	"	" "	Orthoceras vertebrale. H.	1	"	"	"
381	"	" "	Orthoceras strigatum. H.	2	Pleasant Grove, Olm. Co.	"	"
392	Oct. 1872.	" "	Block with fragment of Orthis bella-rugosa. Con.	1	St. Charles.	"	"
395	"	" "	Orthis.	1	Rochester, Olmsted Co.	"	" Same as 652.
399	1872	W. D. Hurlbut.	Asaphus extans. H. (?) v. 90.	1	Trenton Falls, N. Y.	"	" Has a pustulated instead of a lamellose surface.
410	Oct. 1872.	Geol. Sur.	Asaphus gigas. H. and Strophomena filitexta. H	1	St. Charles.	"	N. H. Winchell.
429	Oct. 1875.	" "	Orthis. n. sp.?	2	Spring Valley.	Galena?	N. H. Winchell, (ventral valve is the most convex and hence cannot be Orth's occidentalis, v. Pal. Ohio vol. I. p. 96. The plications are also too coarse.

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
635	Nov. 1876	Centennial Exb	Volcanic Scoria	m'y	Kilauea, Sandwich Isl.		
636	"	" "	" " Pele's Hair	1	" " "		
637	Aug. 1873	Geol. Sur	Kaoline (green and impure)	1	Birch Coolie, Minn		Cut in rectangular block
638	"	"	" " "	1	" " "		Natural specimen
639	Nov. 1876	Centennial Exb	Lava tears	2	Kilauea, Sandwich Ils.		
640	Oct. 1872	Geol. Survey	Limonite (after Pyrite)	1	Sugar Loaf, Winona	Low. Mag.	Surface specimen
641	Nov. 1876	Centennial Exb	Water Crystals. (Quartz.)	4	Little Falls, N. Y.		
642	Oct. 1875	Geol. Sur	Orthis. n. sp?	2	Spring Valley	Galena	N. H. Winchell
643	"	"	Orthis	2	Minneapolis	Trenton	"
644	Aug. 1875	"	Orthis	4	Fountain, Fillmore Co.	"	" (Taylor's Quarry.)
645	"	"	Lingula quadrata. Eich	1		"	"
646	"	"	Chaetetes Lycoperdon. H	9	" " "	"	" " "
647	"	"	Strophomena filitexta. H. Pal. vol. I, p. 82 (one ventral valve	1	" " "	"	" " "
648	"	"	Orthis. n. sp?	1	" " "	"	N. H. Winchell, same as 279, 346.
649	Sept. 1875	"		Indf	Olmsted Co.	"	M. W. Harrington
650	?	"	Rhynchonella capax. Con	1	?		?
651	Aug. 1875	"	Orthis. n. sp	1	Fountain, Fillmore Co.	Trenton	N. H. Winchell
652	1872	"	Slabs with Asaphus gigas H. Orthis testudinaria, Dal. and a small Rhynchonellas, also a Gasteropod.	bks 6	Rochester, Olmsted Co.	"	"
653	July 1877	"	Cyrtolites compressus. Con	6	Minneapolis	"	C. L. Herrick
654	1873	"	Ceraurus vigilans H	1	Finn's Glen	"	N. H. Winchell
655	Oct. 1872	"	Leptaena sericea. Sow	1	Petit's Mill	"	"
656	"	"	Schizocrinus nodosus. H	1	"	"	"
657	"	"	Slab with Rhynchonella capax, Con. and Strophomena alternata. H. and Bellerophon bilobatus, H	1	"	"	"
658	"	"	Calcareous tufa	1	Minneapolis		C. L. Herrick

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
659	1872	Geol. Sur	Atrypa recurvirostra. H ... Blocks	6	Rochester, Minn	Trenton	N. H. Winchell
660	"	"	Atrypa recurvirostra. H	Indf	" "	"	" (taken from 659.)
661	Oct. 1872	"	Endoceras proteiforme. var. lineolatum. H	1	Pleasant Grove, (sec. 16)	"	"
662	"	"	Orthoceras junceum. H	1	" "	"	"
663	"	"	Cytoceras annulatum. H. and Orthoceras strig. H	1	" "	"	"
664	Aug. 1877	"	Petraia corniculum. H	Indf	Minneapolis	"	C. L. Herrick
665	"	"		2	"	"	"
666	"	"		Indf	"	"	"
667	"	"		1	"	"	"
668	"	"		1	"	"	"
669	"	"		14	"	"	"
670	"	"		7	"	"	"
671	"	"		2	"	"	"
672	"	"		1	"	"	"
673	"	"		1	"	"	"
674	"	"		9	"	"	"
675	"	"		4	"	"	"
676	"	"		1	"	"	"
677	"	"		2	"	"	"
678	"	"		2	"	"	"
679	"	"		2	"	"	"
680	"	"		1	"	"	"
681	"	"		1	"	"	"
682	"	"		1	"	"	"
683	"	"		12	"	"	"
684	"	"		1	"	"	"
685	"	"		1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
686	Aug. 1877	Geol. Sur.		1	Minneapolis	Trenton	C. L. Herrick
687	"	"		3	"	"	"
688	"	"		1	"	"	"
689	"	"		1	"	"	"
600	"	"		1	"	"	"
691	"	"		1	"	"	"
692	"	"		4	"	"	"
693	"	"		1	"	"	"
695	"	"		1	"	"	"
696	"	"		2	"	"	"
697	"	"		2	"	"	"
668	"	"		1	"	"	"
699	"	"		4	"	"	"
700	"	"		1	"	"	"
701	"	"		5	"	"	"
702	"	"		2	"	"	"
703	"	"		2	"	"	"
704	"	"		1	"	"	"
705	"	"		7	"	"	"
706	"	"		1	"	"	"
707	"	"		2	"	"	"
708	"	"		3	"	"	"
708	"	"		1	"	"	"
709	"	"		1	"	"	"
710	"	"		1	"	"	"
711	"	"		1	"	"	"
712	"	"		1	"	"	" (Green slade.)

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
713	Aug. 1877	Geol. Sur.		2	Minneapolis	Trenton	C. L. Herrick (Green shale)
714	"	"		1	"	"	" " "
715	"	"		1	"	"	"
716	"	"		6	"	"	" (Green shale)
717	"	"		1	"	"	" " "
718	"	"		1	"	"	"
719	"	"		1	"	"	"
720	"	"		2	"	"	"
721	"	"		2	"	"	"
722	"	"		1	"	"	"
723	"	"		1	"	"	"
724	"	"		1	"	"	"
725	"	"		1	"	"	"
726	"	"		1	"	"	"
727	"	"		1	"	"	"
728	"	"		1	"	"	"
729	"	"		1	"	"	"
730	"	"		1	"	"	"
731	"	"		1	"	"	"
732	"	"		1	"	"	" (Green shale.)
733	"	"		2	"	"	" " "
734	"	"		Indf	"	"	" " "
735	"	"		2	"	"	" " "
736	"	"		2	"	"	" " "
737	"	"		Indf	"	"	" " "
738	"	"		"	"	"	Fragment of above "
739	"	"		1	"	"	" " "

Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
740	Aug. 1877	Geol. Sur		2	Minneapolis	Trenton	C. L. Herrick
741	"	"		1	"	"	" (Green shale.)
742	"	"		3	"	"	" " "
743	"	"		1	"	"	"
744	"	"		3	"	"	"
745	"	"		1	"	"	"
746	"	"		1	"	"	"
747	"	"		1	"	"	"
748	"	"		2	"	"	"
749	"	"		1	"	"	"
750	"	"		1	"	"	"
751	"	"		1	"	"	"
752	"	"		1	"	"	"
753	"	"		5	"	"	"
754	"	"		Indf	"	"	" (Green shale.)
755	"	"		"	"	"	"
756	"	"		1	"	"	"
757	Fall, 1876	"		1	"	"	N. H. Winchell
758	"	"		1	"	"	"
759	"	"		1	"	"	"
760	"	"		1	"	"	"
761	"	"		1	"	"	"
762	"	"		1	"	"	"
763	"	"		1	"	"	"
764	"	"		1	"	"	"
765	"	"		1	"	"	"
766	Aug. 1877	"		Indf	"	"	C. L. Herrick

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
767	Aug. 1877	Geol. Sur		5	Minneapolis	Trenton	C. L. Herrick
768	"	"		2	"	"	"
769	"	"		2	"	"	"
770	"	"		1	"	"	"
771	"	"		1	"	"	"
772	"	"		1	"	"	"
773	"	"		Indf	"	"	"
784	"	"		4	"	"	"
775	"	"		1	"	"	"
786	"	"		1	"	"	"
777	"	"		1	"		"
778	"	"		1	"		"
779	"	"		1	"		"
780	"	"		1	"		"
781	"	"		1	"		"
782	"	"		1	"		"
783	"	"		1	"		"
784	"	"		1	"		"
785	"	"		1	"		"
786	"	"		2	"		"
787	"	"		3	"		" (Green shale.)
788	"	"		1	"		"
782	"	"		1	"		" (Green shale.)
790	"	"		2	"		" " "
791	"	"		1	"		" " "
792	"	"		3	"		" " "
793	"	"		1	"		" " "

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
794	Aug. 1877	Geol. Sur.		2	Minneapolis		C. L. Herrick, (Green shale.)
795	"	"		1	"		"
796	"	"		1	"		" (Green shale.)
797	"	"		Indf	"		" " "
798	Jan. 1876	Minn. Disk Co.	Serpentine. (Precious)	3	Newburyport, Mass		
799	Nov. 1876	Cent. Exp.	Graphite	2	Rockingham, Ont		Geol. Sur. of Can. (A. R. C. Selwyn)
800	"	"	Chalcopyrite	1	Almador Co., Cal		N. H. Winchell
801	?	A. D. Roe	Dipyre		Canaan, Conn		
802	Sept. 1873	Geol. Sur.	Gypsum, (Selenite—Crystals)	Indf	Big Stone Lake, Minn	Cretaceo's	N. H. Winchell
803	Sept. 1875	"	Ankerite	1	Lanesboro, Minn	St. Lawrc'e	
804	Dec. 1877	A. K. Ridenour	Modiolopsis pholadiformis. F. & W	1	Oxford, Ohio	Low Sil	
805	"	"	Rhynchonella perlamellosa. Whit	2	Clarksville, Ohio	"	
806	"	"	Ambonychia radiata. Hall	1	Cincinnati, Ohio	"	
807	"	"	Avicula corrugata. James	1	"	"	
808	"	"	Orthis testudinaria. Dal	13	"	"	
809	"	"	Orthis retrorsa. Sal	1	Oxford, O	"	
810	"	"	Orthis dentata. Pander	2	Cincinnati, O	"	
811	"	"	Strophomena loxorhytis. Meek	2	"	"	
812	"	"	Lingula Covingtonensis. Hall. and Whit	1	"	"	
813	"	"	Orthis subquadrata. Hall	2	Clarksville, O	"	
814	"	"	Crania scabiosa. *Hall	3	Cincinnati, O	"	
815	"	"	Orthodesma contracta. Hall	1	"	"	
816	"	"	Orthis fissicosta. Hall	2	"	"	
817	"	"	Modiolopsis modiolaris. Con	2	"	"	
818	"	"	Orthis lynx. Eich	1	"	"	
819	"	"	Anodontopsis Milleri. Meek	2	Versailles, Ind	"	
820	"	"	Orthis occidentalis. Hall	1	Cincinnati, O	"	

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
821	Dec. 1877	A. K. Ridenour	Streptorhynchus elongata. James	2	Clarksville, O	Low. Sil	
822	"	"	Orthis acutilirata. Con	2	"	"	
823	"	"	Strophomena rhomboidalis. Sow	2	"	"	
824	"	"	Strophomena alternata. Hall	2	"	"	
825	"	"	Modiolopsis anodontoides. Con	1	"	"	
826	"	"	Rhynohonella capax. Con	4	"	"	
827	"	"	Orthis biforata. Eich	4	Cincinnati, O	"	
828	"	"	Tellinomya pectenculoides. Hall	3	"	"	
829	"	"	Streptorhynchus planumbona. Hall	2	Clarksville, O	"	
830	"	"	Zygospira modesta. Say	5	Cincinnati, O	"	
831	"	"	Leptæna sericea. Sow	8	"	"	
832	"	"	Streptorhynchus sinuata. Em	2	Clarksville, O	"	
833	"	"	Orthodonta parallela. Hall	1	Cincinnati, O	"	
834	"	"	Streptorhynchus planoconexa. Hall	2	"	"	
835	"	"	Streptorhynchus subtenta. Con	1	Clarksville, O	"	
836	"	"	Trematis multipunctata. Hall	4	Cincinnati, O	"	
837	"	"	Murchisonia bicincta. Hall	4	"	"	
838	"	"	Orthis borealis. Bill	2	Frankfort, Ky	"	
839	"	"	Streptorhynchus sulcata. DeVer	3	Clarksville, O	"	
840	"	"	Zygospira Cincinnatiensis. James	9	Cincinnati, O	"	
841	"	"	Strophomena squamula. James	3	"	"	
842	"	"	Orthis insculpta. Con	3	Clarksville, O	"	
843	"	"	Schizocrania filosa. Hall	1	Cincinnati, O	"	
844	"	"	Tellinomya lavata. Hall	1	"	"	
845	"	"	Orthis plicatella. Hall	6	"	"	
846	"	"	Raphistoma lenticularis. Sow	3	"	"	
847	"	"	Orthis ella. Hall	4	"	"	

Catalogue of Specimens Registered in the General Museum in 1877—Continued. 12

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
848	Dec. 1877	A. K. Ridenour	Orthis Jamesi. Hall	4	Cincinnati, O.	Low Sil.	
849	"	"	Nucleospira fusiformis. Hall	2	Morrow, O.	"	
850	"	"	Orthis emacerata. Hall	4	Cincinnati, O.	"	
851	"	"	Tellinomya obliqua	4	Ohio	"	
852	"	"	Cleidophorus fabula	3	Ohio	"	
853	"	"	Avicula insueta. Con	2	Ohio	"	
901	Nov. 1876	Geo. F. Kunz	Bog Iron ore No. 1	1	Bulau bei Hanau		
902	"	"	Freshwater limestone No. 2	1	Binau		
903	"	"	Loess No. 3	1	Heidelberg	Loess	
904	"	"	Limestone No. 4	1	Naples, Italy		
905	"	"	Tertiary sandstone No. 5	1	Heppenheim	Tertiary	
906	"	"	Molasse No. 6	1	Bern, Switzerland		
907	"	"	Calcareous Conglomerate No. 7	1	Rigi, Switzerland		
908	"	"	Sandstone No. 8	1	Siebengebirge		
909	"	"	Platic Clay No. 9	1	Hemsbach		
910	"	"	Porcelain Jasper No. 10	1	Bilin, Bohemia		
911	"	"	Brown Coal No. 11	1	Teplitz, Bohemia		
912	"	"	Lignite No. 12	1	Salzhausen, Wetterau		
913	"	"	Freshwater Limestone No. 13	1	Stubenthal, Wurtmbu'g		
914	"	"	Tegelkalk No. 14	1	Frankfort-on-the-Main		
915	"	"	Tegelkalk No. 15	1	Wusenau bei Mainz.		
916	"	"	Tripoli Slate No. 16	1	Bilin, Bohemia		
917	"	"	Tile or Brick Earth No. 17	1	Near Vienna		
918	"	"	Calcaire Grossier No. 18		Vangirard. France		
919	"	"	Klebschiefer No. 19		Montmartre, France		
920	"	"	Gypsum No. 20		Montmartre, France		
921	"	"	Flysch No. 21		Bern, Switzerland		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
922	Nov. 1876	Geo. F. Kuntz	Nummulitic Limestone ... No. 22	1	Kressenberg, Bavaria		
923	"	"	Foraminifera Limestone ... No. 23	1	Bavaria		
924	"	"	Upper Chalk ... No. 24	1	Maestricht, Holland		
925	"	"	Chalk ... No. 25	1	Denmark		
926	"	"	Limestone ... No. 26	1	Gossau Alps, Austria		
927	"	"	Glauconitic Chalk ... No. 27	1	Rouen, France		
928	"	"	"Planer" Limestone ... No. 28	1	Teplitz, Bohemia		
929	"	"	"Quader" Sandstone ... No. 29	1	Pyrna, Saxony		
930	"	"	Gault ... No. 30	1	Gyl Evegne, France		
931	"	"	Wælderthon ... No. 31	1	Niederschœna, Saxony		
932	"	"	Wælderthon ... No. 32	1	Santel		
933	"	"	Hastings Sandstone ... No. 33	1	Bredenbeck		
934	"	"	Lithographic Slate ... No. 34	1	Solenhofen, Bavaria		
935	"	"	Coralline Limestone ... No. 35	1	Istein, Baden		
936	"	"	Jura Limestone ... No. 36	1	Kandern, Baden		
937	"	"	Oxford Clay ... No. 37	1	Dives, France		
838	"	"	Ornatenthon ... No. 38	1	Gommelshausen, Wurt		
939	"	"	Cornbrash ... No. 39	1	Vœgesheim, Baden		
940	"	"	Oolitic Limestone ... No. 40	1	Kandern, Baden		
941	"	"	Clay Ironstone ... No. 41	1	Wurtemberg		
942	"	"	Lias Slate ... No. 42	1	Boli, Wurt	Lias	
943	"	"	Lias Marl ... No. 43	1	Kulmbach, Bavaria	"	
914	"	"	Lias Limestone ... No. 44	1	Malsch, Baden	"	
945	"	"	Lias Sandstone ... No. 45	1	Wurtemburg	"	
946	"	"	Slate ... No. 46	1	St. Cassian, Tyrol		
947	"	"	Limestone ... No. 47	1	Aussee, Styria		
948	"	"	Upper Keuper Sandstone ... No. 48	1	Degerloch, Wurtem		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.		No. of Specimens.	Locality.	Formation	Collector and Remarks.
949	Nov. 1876	Geo. F. Kunz	Middle Keuper Sandstone	No. 49	1	Heilbronn, Wurt		
950	"	"	Keuper Marl	No. 50	1	Malsch, Baden		
951	"	Geol. Sur	Sandstone	No. 51	1	Sinsheim, Baden		
952	"	"	Slate	No. 52	1	Sinsheim, Baden		
953	"	"	"Muschelkalk"	No. 53	1	Wiesloch, Baden		
954	"	"	Lower "Muschelkalk"	No. 54	1	Mostroh		
955	"	"	"Bunter" Sandstone	No. 55	1	Heidelberg		
956	"	"	Sandstone	No. 56	1	Kaiserslautern		
957	"	"	Permian Gypsum	No. 57	1	Ihlfeld, Harz	Permian	
958	"	"	"Nechstein"	No. 58	1	Ilmenau, Thuringia		
959	"	"	Permian Dolomite	No. 59	1	Eisleben, Thuringia	Permian	
960	"	"	Copper Slate	No. 60	1	Rieschelsdorf, Hessia		
961	"	"	Permian "(Todtliegendes")	No. 61	1	Baden	Permian	
962	"	"	Coal Slate	No. 62	1	Saarbrucken	Carb	
963	"	"	Cannel Coal	No. 63	1	Wigan, Lancashire	"	
964	"	"	Carboniferous Sandstone	No. 64	1	Zwickau, Saxony	"	
965	"	"	Carboniferous Sandstone	No. 65	1	Le Fay, France	"	
966	"	"	Carboniferous Limestone	No. 66	1	Tournay, France		
967	"	"	Devonian Limestone	No. 67	1	Oberscheid, Nassau	Devonian	
968	"	"	Devonian Limestone	No. 68	1	Hof, Bavaria	"	
969	"	"	Gray Wacke	No 69	1	Ober Lahnstein		
970	"	"	Clay Slate	No. 70	1	Kaub on the Rhine		
971	"	"	Silurian Limestone	No. 71	1	Prague, Bohemia	Silurian	
972	"	"	Silurian Limestone	No. 72	1	Prague, Bohemia	"	
973	"	"	Slate	No. 73	1	Hof, Bavaria		
974	"	"	Gneiss	No. 74	1	Freiberg, Saxony		
975	"	"	Mica Slate	No. 75	1	Gadernheim, Hessia		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
976	Nov. 1876	Geo. F. Kunz	Talcose Slate ... No. 76	7	Kolmbach		
977	"	"	Granular Limestone ... No. 77	1	Auerbach		
978	"	"	Granite ... No. 78	1	Schlierbach		
979	"	"	Graphic Granite ... No. 79	1	Zwiesel, Bavaria		
980	"	"	Syenite ... No. 80	1	Reichenbach		
981	"	"	Hornblende Rock ... No. 81	1	Schriesheim, Baden		
982	"	"	E·logite ... No. 82	1	Silberbach		
983	"	"	Diorite ... No. 83	1	Dillenberg, Nassau		
984	"	"	Aphanite ... No. 84	1	Sechshelder, Nassau		
985	"	"	Spilite ... No. 85	1	Limburg		
986	"	"	Serpentine ... No. 86	1	Kupferberg, Bavaria		
987	"	"	Gabbro ... No. 87	1	Wurlitz		
988	"	"	Porphyry ... No. 88	1	Ziegelhausen, Baden		
989	"	"	Melaphyre ... No. 89	1	Ilmenau, Thuringia		
990	"	"	Basatt ... No. 90	1	Auerbach, Hessia		
991	"	"	Doleryte ... No. 91	1	Katzenbuckel		
992	"	"	Amygdaloidal Doleryte ... No. 92	1	Sasbach, Baden		
993	"	"	Phonolyte ... No. 93	1	Rhaengebirge		
994	"	"	Trachyte ... No. 94	1	Stenzelberg, Siebeng'b'g		
995	"	"	Sanidine Trachyte ... No. 95	1	Drachenfels		
996	"	"	Trachyte Conglomerate ... No. 96	1	Ober.Dollendorf, Rhine		
997	"	"	Trass ... No. 97	1	Brohl		
998	"	"	Pitchstone ... No. 98	1	Meissen, Saxony		
999	"	"	Obsidian ... No. 99	1	Lipari Isles		
1000	"	"	Lava ... No. 100	1	Mt. Vesuvius, Italy		
1001	"	"	Calamine	178	Ogdensburg, N. Y.		
1002	"	"	Calamine and Smithsonite	3	"		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1003	Nov. 1876	Geo. F. Kunz	Calamine	1	Franklin, N. J		
1004	"	"	Natrolite	96	Bergen Hill, N. J		
1005	"	"	Datolite	138	"		
1006	"	"	Calcite resembling Datolite	1	"		
1007	"	"	Calcite (modified)	5	"		
1008	"	"	Calcite.	78	"		
1009	"	"	Calcite.	11	Franklin, N. J		
1010	"	"	Mesolite.	10	Bergen Hill, N. J		
1011	"	"	Datolite and compact Mesolite	2	"		
1012	"	"	Compact Mesolite	1	"		
1013	"	"	Mesolite and Datolite	1	"		
1014	"	"	Peculiar form of Calcite	1	"		
1015	"	"	Tabular Calcite	5	"		
1016	"	"	Natrolite, Analcite and Prehnite	1	"		
1017	"	"	Thomsonite	1	"		
1018	"	"	Smithonite	7	Franklin, N. J		
1019	"	"	Quartz	30	Hot Springs, Ark		
1020	"	"	Sussexite	1	Franklin, N. J		
1021	"	"	Seyberlite	1	Amity, N. Y		
1022	"	"	Datolite and Pyrite	2	Bergen Hill, N. J		
1023	"	"	Willemite (Troostite)	109	Franklin, N. J		
1024	"	"	Zincite (Ruby)	31	"		
1025	"	"	Amphibole (Hornblende)	135	"		
1026	"	"	Brown Tourmaline	1	"		
1027	"	"	Yellow Stilbite	1	Bergen Hill, N. J		
1028	"	"	Sphalerite (Compact Blende)	4	Bethlehem, Pa		Peculiar to locality
1929	"	"	Sphalerite (Blende)	36	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1030	Nov. 1876	Geo. F. Kunz	Biotite (Black Iron Mica)	1	Franklin, N. J		
1031	"	"	Spartaite	5	"		
1032	"	"	Egyptian Marble	1	Italy		
1033	"	"	Chalcopyrite	1	Queensland		
1034	"	"	Cassiterite	1	New South Wales		
1035	"	"	Hydraulic Cement (Rock)	1	Rondout, N. Y		
1036	"	"	Franklinite	9	Franklin, N. J		
1037	"	"	Sphalerite (Compact Blende)	2	Bethlehem, Pa		Peculiar variety, only found here
1038	"	"	Compact Thomsonite	1	Bergen Hill, N. J		
1039	"	"	Willemite and Thomsonite	1	Franklin, N. J		
1040	"	"	Pectolite	175	Bergin Hill, N. J		
1041	"	"	Mountain Paper	1	West Chester Co., N. Y		
1042	"	"	Brown Garnet	119	Franklin, N. J		
1043	"	"	Brown Garnet	1	"		The rest Wellemite (Troostite) and perhaps Pyroxene (Jeff.)
1044	"	"	Zincite	53	"		
1045	"	"	Quartz (Chert) in Schoharie grit	1	Schoharie, N. Y		
1046	"	"	Phlogopite	27	Franklin, N. J		Transparent through the sides
1047	"	"	Franklinite	273	"		
1048	"	"	Willemite	157	"		
1049	"	"	Franklinite and Zincite	180	"		
1050	"	"	Zincite (with Calcite)	49	"		
1051	"	"	Pyroxene	88	"		
1052	"	"	Chalcopyrite	4	"		
1053	"	"	Gahnite (Dysluite)	50	"		
1054	"	"	Graphite	100	New York		
1055	"	"	Tourmaline (Green)	34	Franklin, N. J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1056	Nov. 1876	Geo. F. Kunz	Talc	12	Franklin, N. J		
1057	"	"	Surpentine (Precious Serpentine)	3	Montville, N. J		
1058	"	"	Calcite	3	Franklin, N. J		
1059	"	"	Apatite	18	"		
1060	"	"	Zincite and Willemite	3	"		
1061	"	"	Lepidomelane	9	"		
1062	"	"	Willemite, Franklinite and Zincite	8	"		
1063	"	"	Sussexite, Zincite and Franklinite	1	"		
1064	"	"	Franklinite, Zincite, Rhodochrosite (Dialogite) and Tephroite	1	"		
1065	"	"	Red and Green Corundum, Chondrodite	2	"		
1066	"	"	Garnet (Essomite)	1	"		
1067	"	"	Pyroxene and Amphibole (Pargasite)	2	"		
1068	"	"	Gahnite (Dysluite) and Garnet	3	"		
1069	"	"	Spinel	9	"		
1070	"	"	Chondrodite	8	"		
1071	"	"	Chondrodite and Fluorite	2	"		
1072	"	"	Epidote	5	"		
1073	"	"	Willemite (Troostite) and Franklinite	1	"		
1074	"	"	Pyroxene (Jeffersonite) and Apatite	1	"		
1075	"	"	Amphibole (Hornblende) and Titanite (Sphene)	30	"		
1076	"	"	Yellow Calcite	4	"		
1077	"	"	Black Garnet	35	"		
1078	"	"	Pyroxene (Jeffersonite)	44	"		
1079	"	"	Calcite (Stalactite)	1	Durham Cave, 10 mi. below Easton, Pa.		
1080	"	"	Native Copper	9	Lake Superior		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1081	Nov. 1876	Geo. F. Knnz	Garnet (Colophonite) and Franklinite	2	Franklin, N. J		
1082	"	"	Garnet, (Colophonite) Franklinite & Willemite.	1	"		
1083	"	"	Garnet, (Colophonite)	7	"		
1084	"	"	Pyroxene (Jeffersonite) and Garnet	3	"		
1085	"	"	Garnet, var. Melanite	75	"		
1086	"	"	Corundum (Sapphire)	1	"		
1087	"	"	Azurite	2	Chili		
1088	"	"	Iridescent Datolite	2	Bergen Hill, N. J		Very rare
1089	"	"	Prehnite	39	"		
1090	"	"	Feldspar	52	Turin, N. Y.		
1091	"	"	Ruby Corundum	2	Franklin, N. J		
1092	"	"	Gold	2	North Carolina		
1093	"	"	Gold Quartz	3	California		
1094	"	"	Calcite	1	England		
1095	"	"	Pyromorphite (Brown Lead Ore)	1	Ems, Germany		
1096	"	"	Millerite	2	Gap Mimes, Pa		
1097	"	"	Pyrite	1	Roxbury, Ct		
1098	"	"	Surpentine (Chrysotile)	1	Montville, N. J		
1099	"	"	Talcose Slate	1	Staten Island		
1100	"	"	Rensselærite	3	St. Lawrence Co., N. Y		
1101	"	"	Amphibole (Asbestus)	2	Baltimore, Md		
1102	"	"	Amphibole (Hornblende)	1	Amity, N. Y		
1103	"	"	Apophyllite and Laumontite	2	Bergen Hill, N. J		
1104	"	"	Fontainebleau Sandstone	1	Europe		Concretions
1105	"	"	Millerite, Hematite (Specular Iron) & Siderite	1	Antwerp, N. J		
1106	"	"	Calamine in Sphalerite (Blende)	2	Granby, Mo		
1107	"	"	Fibrous Red Hematite	1	Maryland		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
1108	Nov. 1876	Geo. F. Kunz	Blue Corundum	1	Franklin, N. J		
1109	"	"	Staurolite	1	Georgia		
1110	"	"	Serpentine (Baltimorite)	1	Wood mine, Texas, Lancaster Co., Pa.		
1111	"	"	Anthophyllite	1	Wood mine. Texas, Lancaster Co., Pa.		
1112	"	"	Black Garnet	2	Franklin, N. J		
1113	"	"	Brown Garnet and Epidote	4			
1114	"	"	Aluminite (Hallite)	5	Texas, Pa.		
1115	"	"	Grey Tephroite and Zincite	1	Franklin, N. J		
1116	"	"	Hematite (Specular Iron)	1	Island of Elba		
1117	"	"	Magnetite	2	Sussex Co., N. Y		
1118	"	"	Rutile (Rutilated Quartz)	1	Switzerland		
1119	"	"	Pinite (Agalmatolite)	1	China		
1120	"	"	Pent. Dodec Pyrite	11	New Jersey		
1121	"	"	Corundum	4	Franklin, N. J		
1122	"	"	Cuprite	1	Valparaizo, Chili		
1123	"	"	Prehnite and Natrolite	4	Bergen Hill, N. J		
1124	"	"	Silver aud Gold in Pyrite, Galenite (Galena)	1	California		
1125	"	"	Pyrite	40	Franklin, N. J		
1126	"	"	"Greenish Mica"	2	Connecticut		
1127	"	"	Millerite	3	Antwerp, N. Y		
1128	"	"	Phlogopite	6	St. Lawrence Co., N. Y.		
1129	"	"	Vesuvianite (Idocrase)	5	Amity, N. Y		
1130	"	"	Brookite	1	Ellenville, N. Y		Trausluoent yellow on quartz
1131	"	"	Stilbite	2	Poorah, Hindostan		
1132	"	"	Datolite and Natrolite	11	Bergen Hill, N. J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1133	Nov. 1876	Geo. F. Kunz	Datolite and Stilbite	2	Bergen Hill, N.J		
1134	"	"	Apophyllite	67	"		
1135	"	"	Calcite and Stilbite	5	"		
1136	"	"	Quartz and Limonite,	1	Hoboken, N. J		
1137	"	"	Stilbite	6	New York City		
1138	"	"	Calcite and Pyrite	11	Bergen Hill, N. J		
1139	"	"	Epidote	12	Franklin, N. J		
1140	"	"	Quartzite Conglomerate	1	Morristown, N. Y.		
1141	"	"	Crystalline Furnace Slag	1	Easton, Pa		
1142	"	"	Smithsonite	4	Franklin, N. J		
1143	"	"	Limonite and Gœthite (Lepidokrokite)	2	Chestnut Hill, Pa		
1144	"	"	Chabazite	1	New York City		
1145	"	"	Quartz	1	Dauphiney, France		
1146	"	"	Zincite and Tephroite	9	Franklin, N. J		
1147	"	"	Franklinite and Tephroite	9	"		
1148	"	"	Franklinite, Zincite and Tephroite	16	"		
1149	"	"	Franklinite, Zincite and Rhodonite	1	"		
1150	"	"	Calcite and Analcite	7	Bergen Hill, N.J		
1151	"	"	Witherite	6	England		
1152	"	"	Magnesite, compact	7	Hoboken, N. J		
1153	"	"	Dolomite (Pearl Spar)	4	Lockport, N. Y	Niagara	
1154	"	"	Dolomite(Pearl Sp'r)and Calcite (DogTooth Sp'r	1	"		
1155	"	"	Serpentine	2	Gouverneur, N, Y		
1156	"	"	Sussexite, Ruby Zincite and Rhodochrosite (Dia.	1	Franklin, N. J		
1157	"	"	Herschelite and Gismondite in Trachyte	1	Cyclopean Islands		
1158	"	"	Slickensides	3	Franklin, N. J		
1159	"	"	Pectolite and Prehnite	3	Bergen Hill, N.J		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1160	Nov. 1876	Geo, F. Kunz	Stilbite	17	Bergen Hill, N.J		
1161	"	"	Sphalerite (Blende)	4	Missouri		
1162	"	"	Calcite (Dog Tooth Spar)	3	Lockport, N. Y		
1163	"	"	Spinel and Chondrodite	3	Franklin, N. J		
1164	"	"	Ophiolyte	1	New York City		
1165	"	"	Datolite and Calcite	3	Bergen Hill, N.J		
1166	"	"	Prehnite and Sphalerite (Blende)	1	"		
1167	"	"	Prehnite, Gmelinite and Blende	5	"		
1168	"	"	Ægirite	14	Near Magnet Cove, Ark		
1169	"	"	Chrysocolla	1	Maryland		
1170	"	"	Chrysocolla and Atacamite	1	"		
1171	"	"	Wulfenite and Pyromorphite	3	Southampton, Mass		
1172	"	"	Limonite	10	Staten Island		
1173	"	"	Quartz (Silicified Wood)	1	Colorado		
1174	"	"	Feldspar and Ægirite	1	Near Magnet Cove, Ark		
1175	"	"	Trap Crystals	2	Bergen Hill, N.J		
1176	"	"	Chalcopyrite	8	Tennessee		1
1177	"	"	Quartz (Moss-agate)	5	Cheyenne, W. T		
1178	"	"	Copalite (Copal)	4	Zanzibar, Africa		
1179	"	"	Quartz (Smoky)	5	Colorado (Pikes Peak)		
1180	"	"	Quartz (Chalcedony)	2	Germany		
1181	"	"	Quartz (Agate)	2	"		With fine design
1182	"	"	Quartz (Jasper)	1	"		
1183	"	"	Quartz (Agate)	1			
1184	"	"	Quartz (Onyx)	1	Oberstein, Germany		
1185	"	"	Quartz (Agate)	1	Oberstein, Germany		
1186	"	"	Smoky Quartz	10	Magnet Cove, Ark		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1187	Nov. 1876	Geo. F. Kunz	Manganite	7	Nova Scotia		
1188	"	"	Sphalerite (Blende) and Pyrite	1	Pike's Peak, Col		Blende resembles Galena
1189	"	"	Magnetite	4	Nova Scotia		
1190	"	"	Beryl	1	Connecticut		
1191	"	"	Feldspar	1	New York City		
1192	"	"	Serpentine with Chromite	1	Hoboken, N. J		
1193	"	"	Magnetite	2	Port Henry		
1194	"	"	Siderite and Gneiss	1	New York City		
1195	"	"	Ægirite on Orthoclase (Feldspar)	1	Near Magnet Cave, Ark.		
1196	"	"	Talc	1	Staten Island		
1197	"	"	Orthoclase	7	New York City		
1198	"	"	Apophyllite and Analcite	3	Bergen Hill, N. J		
1199	"	"	Apophyllite and Prehnite	2	"		
1200	"	"	Magnesite in Cerolite	6	Hoboken, N. J		
1201	"	"	Magnesite	1	"		
1202	"	"	Datolite. White	2	Bergen Hill, N. J		
1203	"	"	Analcite	12	"		
1204	"	"	Datolite and Natrolite	2	"		
1205	"	"	Natrolite and Analcite	2	"		Large cryst. for loc
1206	"	"	Apophylite and Gmelinite	1	"		
1207	"	"	Datolite and Gmelinite	3	"		
1208	"	"	Natrolite and Apophyllite	2	"		
1209	"	"	Orthoclase (Adularia)	1	Windsor, Mass		
1210	"	"	Brown Harmotome	1	Hudson, N. Y		
1211	"	"	Shell Limestone	1	"		
1212	"	"	Graphite (Picture Mica)	1	Lancaster Co., Pa		
1213	"	"	Pyrrhotite	4	St. Anthony's Nose, N. Y.		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
1214	Nov. 1876	Goe. F. Kunz	Chalcopyrite	7	Vermont		
1215	"	"	Chalcopyrite	2	Cuba		
1216	"	"	Pectolite	4	Bergen Hill, N. J		Odd form
1217	"	"	Calcite	1	Unknown		
1218	"	"	Slag	4	From Furnace near Easton, Pa.		
1219	"	"	"From Iron Furnace"	1	Northern New York		
1220	"	"	Mica	4	Franklin, N. J.		
1221	"	"	Natrolite and Stilbite	2	Bergen Hill, N. J		
1222	"	"	Thomsonite	5	"		
1223	"	"	Quartz	1	Hoboken, N. J		
1224	"	"	Garnet (Melanite)	1	Franklin, N. J.		
1225	"	"	Opal	2	Honduras		
1226	"	"	Rhodonite (Crystals of Fowlerite)	1	Franklin, N. J		
1227	"	"	Pyrolusite	1	Germany		
1228	"	"	Pumice	2	"		
1229	"	"	Pyrite	6	Kentucky		
1230	"	"	Datolite and Analcite	2	Bergen Hill, N. J		
1231	"	"	Datolite, Natrolite and Prehnite	1	"		
1232	"	"	Barite	13	Cheshire, Ct		
1233	"	"	Calamine	1	Franklin, N. J		
1234	"	"	Aurichalcite (Green Calamine)	2	Ogdensburg, N. Y		
1235	"	"	Willemite (Troostite) and Franklinite	2	Franklin, N. J		
1236	"	"	Serpentine	6	Hoboken, N. J		
1237	"	"	Hematite (Specular Iron) after Franklinite	1	Franklin, N. J		
1238	"	"	Brucite	2	Hoboken, N. J		
1239	"	"	Hydromagnesite	5	"		

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Seiral Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1240	Nov. 1876	Geo. F. Kunz	Ægirite with Nephelite, (Elæolite)	6	Magnet Cave, Ark		
1241	"	"	Rutile (Nigrine)	38	"		
1242	"	"	Phosphatic Nodule	5	Charleston, S. C.		
1243	"	"	Wulfenite and Pyromorphite	5	Southampton, Mass		
1244	"	"	Quartz (Itacolumite)	7	North Carolina		
1245	"	"	Dolomite	3	Westchester Co., N. Y.		
1246	"	"	Chromite	1	Texas, Pa		
1247	"	"	Tourmaline	1	Delaware Co., Pa		Detached
1248	"	"	Columbite	4	New Alstead, N. H		
1249	"	"	Sussexite and Tephroite	1	Franklin, N. J		
1250	"	"	Cerussite and Pyromorphite	1	Phœnixville, Pa		
1251	"	"	Franklinite and Willemite	10	Franklin, N. J		
1252	"	"	Greenockite on Sphalerite (Blende)	2	Granby, Mo		
1253	"	"	Barite and Pyrite	1	Scales Mound, Ill		
1254	"	"	Brown Tourmaline	30	New York City		
1255	"	"	Psilomelane and Pyrolusite	2	Northern New York		
1256	"	"	Stibnite, Artificial	2	Hungary		
1257	"	"	Corundum	1	North Carolina		
1258	"	"	Aragonite	1	Unknown		
1259	"	"	Chabazite (Acadialite)	1	Nova Scotia		
1260	"	"	Dufrenite	2	Monmouth Co., N. J		
1261	"	"	Mineral Coal (Lignite)	5	England		
1262	"	"	Fossiliferous Hematite	1	Clinton, N. Y		
1263	"	"	Magnetite	1	Unkown		
1264	"	"	Radiated Gypsum	1	Nova Scotia		
1265	"	"	Barite	2	Scales Mound, Ill		
1266	"	"	Penninite (Kammererite)	3	Lancaster Co., Pa		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1267	Nov. 1876	Geo. F. Kunz	Brookite (Arkansite) on Quartz	7	Magnet Cave, Ark.		
1268	"	"	Brookite on Quartz	4	"		
1269	"	"	Willemite (Williamsite)	1	Texas, Pa.		
1270	"	"	Fluorite	8	Franklin, N. J		
1271	"	"	Apatite	1	Rossie, N. Y.		
1272	"	"	Smithsonite	2	Bethlehem, Pa		
1273	"	"	Ripidolite (Clinochlore)	1	Texas, Pa.		
1274	"	"	Sphalerite (Cleiophane)	4	Franklin, N. J.		
1275	"	"	Limonite (Bog Iron)	1	New York		
1276	"	"	Deweylite	1	Texas, Pa.		
1277	"	"	Red Hematite	4	Nova Scotia		
1278	"	"	Amphibole (Hornblende) and Fluorite (Fluor).	1	Franklin, N. J.		
1279	"	"	Amphibole (Hornblende) and Apatite	1	"		
1280	"	"	Talcose Slate	1	Staten Island		
1281	"	"	Gypsum	1	Cape Breton, N. Scotia.		
1282	"	"	Sphalerite (Blende) and Greenockite	1	Granby, Mo.		
1283	"	"	Calcite, Epidote and Copper	1	Lake Superior		
1284	"	"	Greenockite and Asphaltum (Bitumen) on Pyrargyrite (Ruby-Blende)	1	Oronogo, Mo.		
1285	"	"	Sphalerite (Ruby Zinc-Blende)	4	"		
1286	"	"	Gypsum (Selenite)	3	Nova Scotia		
1287	"	"	Smithsonite on Calamine	1	Granby, Mo.		
1288	"	"	Siderite	1	New Yolk City		
1289	"	"	Galenite (Galena)	2	Missouri		Peculiar Crystals
1290	"	"	Galenite, (Galena) Feathery	1	"		
1291	"	"	Wulfenite	6	Southampton, Mass		
1292	"	"	Regalar	3	Turkey		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
							27
1293	Nov. 1876	Geo. F. Kunz	Cyanite	1	Pennsylvania		
1294	"	"	Stilbite (Sphærostilbite)	2	Bergen Hill, N.J		Very rare
1295	"	"	Titanite (Sphene var Lederite)	1	Franklin. N. J		
1296	"	"	Wernerite (Scapolite)	16	Franklin, N. J		
1297	"	"	Tourmaline	1	Lambertville, Pa		
1298	"	"	Psilomelane	2	Hot Springs, Ark		
1299	"	"	"Pipe Ore"	2	Kentucky		
1300	"	"	Melaconite (Tenorite) and Calcite	1	Unknown		
1301	"	"	Zincite (Crystals of yellow Oxyde of Zinc)	1	Franklin, N. J		"From fused ore heaps."
1302	"	"	Psilomelane	2	Virginia		
1303	"	"	Molybdenite	1	Haddam, Conn		
1304	"	"	Ripidolite (Clinochlore)	4	Lancaster Co., Pa		
1305	"	"	Atacamite	2	Atacama, Chili		
1306	"	"	Prehnite, Thomsonite and Laumontite	1	Bergen Hill, N.J		
1307	"	"	Dioryte	1	"		
1308	"	"	Mineral Coal (Lignite)	1	Alaska		
1309	"	"	Azurite	1	Chili, S. A		
1310	"	"	Spodumene	1	Franklin, N. J		
1311	"	"	Amphibole (Tremolite)	1	Lewis Co., N. Y		
1312	"	"	Chalcocite	2	Bristol, Conn		
1313	"	"	Hypersthene	3	Lewis Co., N. Y		
1314	"	"	Ferruginous Quartz	5	Brooklyn, N. Y	Drift	
1315	"	"	Siderite	1	Easton, Pa		
1316	"	"	Talc (Steatite Pseudo after Pyroxene)	4	Franklin, N. J		
1317	"	"	Cacoxenite	1	Antwerp, N. Y		
1318	"	"	Zaratite	4	Texas, Pa		
1319	"	"	Amphibole (Hornblende) and Graphite	1	Amity, N. Y		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1320	Nov. 1876	Geo. F. Kunz	Uraconite (Uranochre)	1	St. Just, Scotland		
1321	"	"	Anglesite	1	Phœnixville, Pa.		
1322	"	"	Hypersthene and Pyrite	1	Franklin, N. J		
1323	"	"	Amphibole (Hornblende) and Apatite	1	"		
1324	"	"	"Silver Mica"	1	"		
1325	"	"	Schorlomite	9	Magnet Cove, Ark		
1326	"	"	Garnet	1	Franklin, N. J		
1327	"	"	Quartz	10	"		
1328	"	"	Tourmaline	8	"		
1329	"	"	Hypersthene	1	"		
1330	"	"	Seybertite	2	"		
1331	"	"	Talc (Steatite, Pseudo, after some mineral)	1	"		
1332	"	"	Slickensides on White Topaz	1	"		
1333	"	"	Talc (Steatite on Graphite)	1	"		
1334	"	"	Phlogopite	2	Sterling, N. Y.		
1335	"	"	Tourmaline	2	New York City		
1336	"	"	Garnet (Melanite) containing Schorlomite	4	Magnet Cove, Ark		
1337	"	"	Rhodochrosite (Dialogite)	2	Franklin, N. J		
1338	"	"	Willemite (Green—rare color)	11	"		
1339	"	"	Dolomite (Perl Spar) in trans Gypsum (Silenite)	1	Lockport, N. Y		
1340	"	"	Zincite and Dialogite	1	Franklin, N. J		
1341	"	"	Niccoliferous Pyrites	15	"		
1342	"	"	Franklinite and Lepidomelane (Black Mica)	1	"		
1343	"	"	Chalcopyrite	1	California		
1344	"	"	Sphalerite (Blende)	117	Oronogo, Mo		
1345	"	"	Hematite	1	Antwerp, N. Y		
1346	"	"	Quartz (Chalcedony)	1	Mt. Tom, Mass		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1347	Nov. 1876	Geo. F. Kunz	Quartz (Flint), with fossils from chalk	1	England		
1348	"	"	"Lithomarge."	1	Bergen Hill, N. J		
1349	"	"	Prehnite and Thomsonite	1	"		
1350	"	"	Orthoclase	1	Dixon's Quarry, Del		
1351	"	"	Malachite in Red Hematite	1	Maryland		
1352	"	"	Stilbite	4	Franklin, N. J		
1353	"	"	Brown Tourmaline	2	"		
1354	"	"	Red Hematite	1	Staten Island		
1355	"	"	Mineral Coal (Cannel Coal)	2	England		
1356	"	"	Mineral Coal (Anthracite)	1	Scranton, Pa		
1357	"	"	Quartz	9	Ellenville, N. Y		
1358	"	"	Quartz	1	Switzerland		
1359	"	"	Fluorite	1	Muscalonge Lake, N. Y.		
1360	"	"	Garnet (Essonite)	1	New Hampshire		
1361	"	"	Pyroxene and Amphibole (Hornblende)	2	Franklin, N. J		
1362	"	"	Sphalerite (Blende) and Asphaltum (Bit'n)	1	Missouri		
1363	"	"	Amphibole (Hornblende) and Graphite	1	Franklin, N. J		
1364	"	"	Spinel	1	Hamburg, N. Y		
1365	"	"	Gypsum (Selenite)	1	Nova Scotia		
1366	"	"	Malachite	1			
1367	"	"	Chromite	1	California		
1368	"	"	Serpentine	1	Hoboken, N. J		
1369	"	"	Epidote	2	Lake Superior		
1370	"	"	Epidote and Orthoclase	3	"		
1371	"	"	Epidote and Quartz	1	"		
1372	"	"	Green and Red Corundum	1	Franklin, N. J		
1373	"	"	Sphalerite (Blende) and Galenite (Galena)	3	Oronogo, Mo		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1374	Nov. 1876	Geo. F. Kunz	Copper in Calcite with Epidote	2	Lake Superior		
1375	"	"	"Spiegeleisen"	1	Sweden		
1376	"	"	Magnetite	1	Franklin, N. J		
1377	"	"	Amygdaloid	1	Massachusetts		
1378	"	"	Galenite in Fluorite	2	Galena, Ill		
1379	"	"	Pyrargyrite (Ruby Blende)	3	Oronogo, Mo		
1380	"	"	Siderite (Carbonate of Iron)	1	North Carolina		
1381	"	"	Psilomelane	2	Northern New York		
1382	"	"	Chromite and Penninite	2	Texas, Pa		
1383	"	"	Calamine and Sphalerite (Blende)	1	Missouri		
1384	"	"	Calcite and Dolomite (Pearl Spar)	1	Lockport, N. Y		
1385	"	"	Quartz (Chalcedony) on Trihedral Quartz	1	Poorah, Hindostan		
1386	"	"	Galenite and Pyrargyrite (Ruby Blende)	2	Oronogo, Mo		
1387	"	"	White and Red Zincite	2	Franklin, N. J		
1388	"	"	Calamine	2	Granby, Mo		
1389	"	"	Epidote and Orthoclase (Feldspar)	9	Lake Superior		
1390	"	"	Galenite	6	Oronogo, Mo		
1391	"	"	Franklinite and Ruby Zincite	2	Franklin, N. J		
1392	"	"	Ferruginous Quartz	1	Connecticut		
1393	"	"	Pinite (Agalmatolite)	1	China		Chinese figure stone
1394	"	"	Apatite	4	Bob Lake, Canada		
1395	"	"	"Kidney Ore,"	1	Bethlehem, Pa		
1396	"	"	Red Hematite	1	Antwerp, N. Y		
1397	"	"	Limonite	3	Salisbury, Conn		
1398	"	"	Diaspore	2	Chester, Mass		
1399	"	"	Slag from Furnace	1	New York		
1400	"	"	Cuprite	1	England		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
1401	Nov. 1876	Geo. F. Kunz	Pyrite. Pent. Dodec	1	Belgium		
1402	"	"	Sulphur	1	Sabine, West Indies		
1403	"	"	Native Bismuth	1	Connecticut		
1404	"	"	Pyrophyllite	1	Deep River, N. C.		
1405	"	"	Collyrite (Dillnite) with Diaspore	1	Shemnitz, Hungary		
1406	"	"	Feldspar	1	Desert of Sinai, Africa		
1407	"	"	Garnet	1	Piedmont, Italy		
1408	"	"	Garnet	2	New Town, Conn		
1409	"	"	Garnet	1	Canada		
1410	"	"	Garnet	1	St. Lawrence Co., N. Y.		
1411	"	"	Quartz (Chalcedony)	1	Poonah, Hindostan		
1412	"	"	Beauxite	1	Cabasse. France		
1413	"	"	Feldspar	2	Lewis County, N. Y.		
1414	"	"	"Red Ochre"	1	Staten Island		
1415	"	"	Beryl	2	Ackworth, N. H.		
1416	"	"	Heulandite	1	New York City		
1417	"	"	Serpentine (Marmolite)	1	Hoboken, N. Y.		
1418	"	"	Calamine	1	Saucon Valley, Pa		
1419	"	"	Quartz (Chalcedony)	1	Florida		
1420	"	"	Pyrite in Coal Shale	1	Scanton, Pa		
1421	"	"	Hauynite (in Lava)	1	Anderbach, Ger		
1422	"	"	Native Copper with Silver	1	Lake Superior		Showing Silver in spots
1423	"	"	Magnetite	2	Nova Scotia		
1424	"	"	Quartz (Petrified Wood)	1	California		
1425	"	"	White Apatite	1	Santander, Spain		
1426	"	"	Amphibole (Tremolite)	3	Gouverneur, N. Y.		
1427	"	"	Glauberite and Mexite, (Hayesine)	2	Iquique, S. A.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1428	Nov. 1876	Geo. F. Kunz	Aragonite	1	Bastennes Landes, Fr.		
1429	"	"	Quartz (Brown Jasper)	2	Murphreys, Cal.		
1430	"	"	Orthoclase	1	Liperville, Pa.		
1431	"	"	Quartz (Silicified Wood)	1	Nevada County, Cal.		
1432	"	"	Cerolite	1	Hoboken, N. J.		
1433	"	"	Molybnite	1	Westmoreland, Mass.		
1434	"	"	Cyanite	2	Trumbull, Conn.		
1435	"	"	Serpentine	1	St. Lawrence, N. Y.		
1436	"	"	Serpentine (Precious Serpentine)	1	Gouverneur, N. Y.		
1437	"	"	Hematite (Specular Iron)	3	Antwerp, N. Y.		
1438	"	"	Sphalerite (Blende)	1	Ellenville, N. Y.		
1439	"	"	Quartz containing Asphaltum (Bitumen)	4	Herkimer County, N. Y.		
1440	"	"	"Hagemanite"	1	Ivigtut, Greenland		
1441	"	"	Cinnabar	1	West California		
1442	"	"	Cerussite	1	Germany		
1443	"	"	Cerussite	2	Davidson County, N. C.		
1444	"	"	Chrysolite (Olivine) in Trap	1	Europe		Exact locality unknown
1445	"	"	Quartz (Calloused)	128	Crystal Mountains, Ark.		
1446	"	"	Quartz	3	Unknown		
1447	"	"	Quartz from Lead Mine	1	Southampton, Mass.		
1448	"	"	Calcite [modified]	1	Bergen Hill, N. J.		
1449	"	"	Quartz (Geode)	1	Illinois		
1450	"	"	Tourmaline and Smoky Quartz	1	New York City		
1451	"	"	Brucite	1	Texas, Pa.		
1452	"	"	Mica Crystals	1	Sterling, N. J.		
1453	"	"	Calcite	1	Roseville, N. J.		
1454	"	"	Flourite and Apatite	1	Franklin, N. J.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1455	Nov. 1876	Geo. F. Kunz.	Amphibole (Byssotite)	1	Bergen Hill, N. J		
1456	"	"	Calcite (Calc Tufa)	1	Cansted, Germany		
1457	"	"	Porcelanite (Porcelain Jasperi	1	Germany		
1458	"	"	Gmelinite	1	Two Islands, N. Scotia		
1459	"	"	Quartz (Jasper) and Serpentine	1	Hoboken, N. J		Point of contact between—
1460	"	"	Graphite Picture Mica	5	Sussex Co., N. J		
1461	"	"	Quartz (Rose)	1	Franklin, N. J		
1462	"	"	Apophyllite	6	Bergen Hill, N. J		Crystals of a rare form
1463	"	"	Mica	2	New Hampshire		
1464	"	"	Titanite (Sphene)	4	Franklin, N. J		
1465	"	"	Titanite (Sphene)	1	Diana, N. Y		
1466	"	"	Mica	2	New York City		
1467	"	"	Quartz (Green Jasper)	1	Connecticut		
1468	"	"	Feldspar	1	France		[form
1469	"	"	Prehnite and Pectolite (crystallized)	1	Bergen Hill, N. J		In separate crystals—very rare
1470	"	"	Geode of Limonite	1	Staten Island, N. Y		
1471	"	"	Pyrites (radiated)	1	Germany		
1472	"	"	Iridescent Limonite	1	Chestnut Hill, Pa		
1473	"	"	Quartz (Amethyst)	2	Thunder Bay, L. S.		
1474	"	"	Quartz	1	Parana, Brazil		
1475	"	"	Quartz (in matrix)	1	Herkimer Co., N. Y		In calciferous sandrock
1476	"	"	Analcite	1	Cyclopean Is.		Rare form—clear and showing
1477	"	"	Rhodonite (Fowlerite crystallized)	1	Franklin, N. J		[face of cube
1478	"	"	Rhodocrosite (Dialogite)	1	Franklin, N. J		Contains Magnesia
1479	"	"	Pyroxene (Pargasite)	2	Franklin, N. J		
1480	"	"	Calcite (Argentine)	4	Montville, N. J		
1481	"	"	Quartz (Bloodstone)	4	Texas		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		Name.	No. of Specimens.	Locality	Formation	Collector and Remarks.
	When.	Whence.					
1482	Nov. 1876	Geo. F. Kunz	Quartz (Rose)	2	Haddam, Ct.		
1483	"	"	Rutile	1	Franklin, N. J		
1484	"	"	Serpentine (Chrysotile)	3	Montville, N. J		
1485	"	"	Compact Garnet	1	New York City		
1486	"	"	Pyroxene	1	Lewis Co. N. Y		
1487	"	"	Cyanite (Rhætizite)	1	Germany		
1488	"	"	Pectolite	2	Bergen Hill, N. J		Rare forms
1489	"	"	Stilbite	1	Nova Scotia		
1490	"	"	Quartz	2	Herkimer Co. N. Y		Showing empty cavities
1491	"	"	Muscovite	2	St. Lawrence, N. Y		
1492	"	"	Calcite	4	Rossie, N. Y		
1493	"	"	Serpentine	3	Montville, N. J		
1494	"	"	Apophyllite containing Ripidolite (Chlorite)	1	Bergen Hill, N. J		
1495	"	"	Copalite (with insects)	2	Zanzibar, Africa		
1496	"	"	Pyrite (auriferous)	1	Queensland		With Chalcopyrite
1497	"	"	Antimony (from Stibnite)	1	Victoria		
1498	"	"	Corundum (Sapphire)	1	Vernon, N. J		
1499	"	"	Mesolite and Calcite	4	Bergen Hill		
1500	"	"	Gmelinite on Datolite	2	Bergen Hill		White and rare
1501	"	"	Apophilyte and Stilbite	1	Bergen Hill, N. J		
1502	"	"	Calcite (Dog Tooth Spar)	5	Missouri		
1503	"	"	"Satin Spar"	2	Wales		
1504	"	"	Naumannite on Garnet	4	Victoria, Australia		
1505	"	"	Pyroxene	1	Lewis Co. N. Y		
1506	"	"	Calcite (Spartaite)	1	Sparta, N. J		
1507	"	"	Red and Green Tourmaline	2	Minas Geras, Brazil		
1508	"	"	Wollastonite	1	Near Haverstraw, N. Y		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1509	Nov. 1876	Geo. F. Kunz	Thomsenolite	1	Tvigtut, Greenland		
1510	"	"	Smithsonite	1	Zinc Co., Mo		
1511	"	"	Pyrite and Galenite	1	Rossie, N. Y		
1512	"	"	Spinel and Corundum	1	Franklin, N. J		
1513	"	"	Franklinite, Zincite and Rhodochrosite (Dialogite.	1	Franklin, N. J		
1514	"	"	"Scapolite" on Amphibole (Hornblende)	1	Franklin, N. J		
1515	"	"	Stilbite	2	Southbury, Connecticut		
1516	"	"	Green Tourmaline	2	Franklin, N. J		
1517	"	"	Manganite	1	Franklin, N. J		
1518	"	"	Wernerite	2	Lewis Co., N. Y		
1519	"	"	Vivianite (Mullicite)	1	Mullica Hill, N. J		
1520	"	"	Analcite (Analcime)	1	Nova Scotia		
1521	"	"	Seybertite (Clintonite)	3	Franklin, N. J		
1522	"	"	Scapolite and Phlogopite	1	Franklin, N. J		
1523	"	"	Barite	1	England		
1524	"	"	Schorlomite and Garnet	1	Magnet Cove, Ark		
1525	"	"	Halloysite (Indianaite)	1	Indiana		
1526	"	"	Unknown	1	Bergen Hill, N. J		
1527	"	"	Pyrite	1	Roxbury, Ct		
1528	"	"	Bornite and Chalcopyrite	1	Bristol, Ct		
1529	"	"	Gold Quartz	1	Victoria, Australia		
1530	"	"	Hematite (Specular Iron.)	1	Germany		
1531	"	"	"Sussexite," (Rare)	23	Franklin, N. J		
1532	"	"	Lepidolite	1	Hebron, Maine		
1533	"	"	Phillipsite in Trachyte	1	Italy		
1534	"	"	Chalcostibite (Antimonial Copper)	1	Chili		
1535	"	"	Garnet (Colophonite)	1	Franklin, N. J.		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formotion	Collector and Remarks.
1536	Nov. 1876	Geo. F. Kunz	Willemite (Troostite) and Calcite (Spartaite)	1	Franklin, N. J.		
1537	"	"	Willemite and Calcite (Spartaite)	2	"		
1538	"	"	Franklinite and Calcite (Spartaite)	8	"		
1539	"	"	Franklinite and Rhodochrosite [Dialogite]	1	"		
1540	"	"	Soda Nitre [Nitratine]	3	Plainsof TerrapaccaS.A		
1541	"	"	Datolite [Massive]	1	Bergen Hill, N. J.		
1542	"	"	Galenite	1	Spain		
1543	"	"	Galenite	2	Illinois		
1544	"	"	Tourmaline	2	Franklin, N. J.		
1545	"	"	Prehnite and Copper	1	Lake Superior		
1546	"	"	"Tvigtite"	1	Tvigtut, Greenland		
1547	"	"	Quartz [Amethyst]	3	Lancaster Co., Pa.		
1548	"	"	Apophyllite and Pectolite [primitive]	1	Bergen Hill, N. J.		
1549	"	"	Vanadinite [Crystallized]	1	Corinthia, Europe		
1550	"	"	Datolite and Yellow Stilbite	1	Bergen Hill, N. J.		
1551	"	"	Pyrite	1			
1552	"	"	Orthoclase	12	Colorado		
1553	"	"	Garnet	5	New Town Ct.		
1554	"	"	Brookite	12	Magnet Cove, Ark.		
1555	"	"	Staurolite	3	New Hampshire		
1556	"	"	Aluminite [Hallite]	4	Notingham, Pa.		
1557	"	"	Chlorastrolite	40	Isle Royale, L. Superior		Rare in Rock
1558	"	"	Azurite	1	Chessy, France		
1559	"	"	Stibiconite [Partzite and Stetefeldtite]	1	Belmont, Nevada		
1560	"	"	Algodonite	1	Chili		
1561	"	"	Cassiterite [Stream Tin]	20	Durango, Mexico		
1562	"	"	Brookite [Arkansite] and Rutile ? [Nigrine]	Indf	Magnet Cove, Ark.		Small and numerous

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Serial No.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1563	Nov. 1876	Geo. F. Kunz	Brookite [Arkansite]	14	Magnet Cove, Ark		Small and numerous
1564	"	"	Topaz	10	Durango, Mexico		
1565	"	"	Titanite [Green Sphene] with Ripidolite [Chlorite.]	2	Tyrol		
1566	"	"	Rutile	9	Lynchburg, Va		
1567	"	"	Native Lead	1	Granada, Spain		
1568	"	"	Vivianite	5	Mullica Hill, N. J		
1569	"	"	Cassiterite [Stream Tin]	14	Durango, Mexico		
1570	"	"	Microlite	2	Chesterfield, Mass		
1571	"	"	Atacamite	1	Chili		
1572	"	"	Spinel [Ruby]	20	Franklin, N. J		
1573	"	"	"Stevensite"	5	Bergen Hill, N. J		
1574	"	"	Fibrous Malachite	1	Germany		
1575	"	"	Quartz	1			
1576	"	"	Mica and Spinel [Ruby]	1	Franklin, N. J		
1577	"	"	Amphibole [Hornblende]	1	Spain		
1578	"	"	Gismondite and Analcite	1	Cyclopean Islands		
1579	"	"	Laumontite and Datolite	2	Bergen Hill, N. J		
1580	"	"	Quartz [Carnelian]	1	Germany		
1581	"	"	Chrysocolla	6	Chili, S. A		
1582	"	"	Smoky Quartz	1	St. Gothard, Switzerl'nd		
1583	"	"	Chrysolite [Olivine]	3	Arizona		
1584	"	"	Quartz [Amethyst]	3	Brazil		
1585	"	"	Lapis-Lazuli	1	Siberia		
1586	"	"	"Black Mica"	2	New York City		
1587	"	"	Iridescent Franklinite and Willemite	1	Franklin, N. J		
1588	"	"	Opal	1	North Carolina		
1589	"	"	Ruby, Sapphire, &c	75	Franklin, N. J		Indefinite

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1590	Nov. 1876	Geo. F. Kuntz	Epidote	1	Tyrol, Europe		
1591	"	"	Quartz crystal penetrated by another crystal	1	Herkimer Co., N. Y.		
1592	"	"	Talc [Steatite, Pseudo-after Staurolite]	1	Germany		
1593	"	"	Stromeyerite	1	Arizona		
1594	"	"	Quartz [Black Jasper]	1	Europe		
1595	"	"	Quartz [Sard or Carnelian]	1	Europe		
1596	"	"	Native silver	1	Mexico		
1597	"	"	Natrolite	1	Vesuvius, Italy		
1598	"	"	Green quartz containing ripidolite [Chlorite]	1	Olisville. N. Y.		
1599	"	"	Calcite	1	Lake Superior		
1600	"	"	Quartz containing Psilomelane	1	Hot Springs, Ark.		
1601	"	"	Opal	10	Hungary		
1602	"	"	Amphibole [Asbestus]	1	North Carolina... [Ark.		
1603	"	"	"Quartz Cappings."	3	40 m. from Hot Springs,		
1604	"	"	Columbite	10	Haddam, Ct.		
1605	"	"	Quartz	28	Herkimer, Co., N. Y.		
1606	"	"	Kalinite [Native Alum]	1	Mt. Morris, N. Y. city		
1607	"	"	Diamond	1	South Africa		
1608	"	"	Topaz [Colored]	Indf	Durango, Mexico		
1609	"	"	Topaz [doubly terminated]	1	" "		
1610	"	"	"Durangite."	Indf	" "		From stream—tin.
1611	"	"	Zircon	3	Franklin, N. J.		
1612	"	"	"Syngenite"	1	Poland, Galacia		Very rare.
1613	"	"	Iridosmine		Oregon		
1614	"	"	Menaccanite [Titanic iron sand containing gold garnet and zircon	Indf	"		
1615	"	"	Menaccanite [Iserius]	Indf	Switzerland		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1616	Nov. 1876	Geo. F. Kuntz	Dioptase	1	Gherghes Steppes, Siber'a		
1617	"	"	Quartz [Agate and Chlorastrolite]	Indf	Isle Royal, L. S.		
1618	"	"	Mellite [Honey Stone]	2	Thuringia		
1619	"	"	Silver [wire]		Mexico		
1620	"	"	Beryl	1	Siberia		
1621	"	"	Apatite	1	Rosse, N. Y.		
1622	"	"	Nytive Tellurium	1	Transylvania		
1623	"	"	Apatite	2			
1624	"	"	Topaz	7	Brazil		
1625	"	"	Andalusite [Chiastolite]	1	Massachusetts		
1626	"	"	Cassitere [stream tin] with topazes and "Dur-angite."	Indf	Durango, Mexico		
1627	"	"	Amphibole [Amianthus]		North Carolina		
1628	"	"	Native copper	1	Lake Superior		From a fissure
1629	"	"	Geode	1	Iowa		
1630	"	"	Quartz [Chalcedony after wood]	1	California		
1631	"	"	Quartz [Silicified wood]	1	Nevada Co. Nev.		
1632	"	"	Asphaltum [Albertite]	3	Nova Scotia		
1633	"	"	Kieserite		Stassfurt, Germany		
1634	"	"	Glauberite		Laramie Plaines, U. S.		
1635	"	"	Picromerite]Kainite]		Stassfurt, Germany		
1636	"	"	Sylvite		" "		
1637	"	"	Tachhydrite		" "		
1638	"	"	Polyhalite		" "		
1639	"	"	Carnallite		" "		[of University of Va.
1640	"	"	Meteoric iron		Virginia		Fall of 1868 from Prof. Mallet,
1641	"	"	Gold	1	Nova Scotia		
1642	"	"	Orthaclase [Amazon Stone]	1	Pike's Peak, Co.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1643	Nov. 1876	Geo. F. Kunz	Graphite	5	Ceylon		
1644	"	"	Kaolinite	5	England		
1645	"	"	Kaolinite	3	Delaware		
1646	"	"	Chrysoberyl	1	Greenfield, N. Y		
1647	"	"	Chalcopyrite and Seybertite (Clintonite)	1	Franklin, N. J		
1648	"	"	Gold	1	Australlia		
1649	"	"	"Silver ore"	1	White Pne, Col		
1650	"	"	Gypsum (Selenite)	1	Zanesville, Ohio		
1651	"	"	Scolecite	1	Poonah, India		
1652	"	"	Lava, with coin put in while hot	1	Vesuvius, Italy		
1653	"	"	Lazulite	6	Lincoln Co., Georgia		
1654	"	"	Limonite	2	Near Franklin, N. J		
1655	"	"	Quartz (Amethyst)	2	England		
1656	"	"	Amphibole [Asbestus]	5	Staten Island, N. Y		
1657	"	"	Mineral coal [Peacock coal]	4	Wilkesbarre, Pa		
1658	"	"	White Staurolite	1	Hanover, N. H		
1659	"	"	Native Silver	1	Chili, S. A		
1660	"	"	Gold and Silver	1	Gould & Curry mine, Cal		
1661	"	"	Serpentine [Antigorite]	1	Antigoras, Piedmont		
1662	"	"	Quartz [Amethyst]	1	Hugnary		
1663	"	"	Molybdite	1	Strahope, N. J		
1664	"	"	Biotite	1	New York State		
1665	"	"	Calcite	1	Rossie, N. Y		
1666	"	"	Amphibole [Radiated Tremolite]	1	Barrington, Mass		
1667	"	"	Octahedrite [Anatase] and Quartz	1	St. Gothard, Switz		
1668	"	"	Lava	2	Vesuvius, Italy		
1669	"	"	Lava	1	Sandwich Islands		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1670	Nov. 1876	Geo. F. Kunz	Pyrite	1	Jeddo Coal Mines, Pa.		
1671	"	"	Pyrite	1	Rossie, N. Y.		
1672	"	"	Rutile	2	Lincoln Co., Georgia		
1673			Rutile	1	Lancaster Co., Pa.		
1674	"	"	Black Tourmaline	1	Rossie, N. Y.		
1675			Tourmaline	1	Haddam, Ct.		
1676	"	"	"Black Mica"	1	Franklin, N. J.		
1677	"	"	"Mica, magnetited"	3	New York City		
1678	"	"	Quartz	1	Dubuque, Iowa		
1679	"	"	Pyrite Sphaeerite (dodecahedral Blende)	1	Pike's Peak, Col.		
1680	"	"	Magnetite (native Magnet)	4	Magnet Cove, Ark.		
1681	"	"	Chalcanthite (native Sulphate of Copper)		Cornwall, England		
1682	"	"	Gypsum	3	Mammoth Cave, Ky.		
1683	"	"	Kaolinite (Argilliform)	2	Woodbridge, N. J.		
1684	"	"	Odd Quartz	1	Magnet Cove, Ark.		
1685	"	"	Doubly Terminated Milky Quartz	1	Magnet Cove, Ark.		
1686	"	"	Quartz	1	Phœnixville, Pa.		
1687	"	"	Calcite	1	Lake Superior		Rock on which Duluth is built.
1688	"	"	"Satin Spar"	4	Nova Scotia		
1689	"	"	Quartz in Calc. Sand Rock	7	Herkimer Co., N. Y.		
1690	"	"	Asphaltum (Bitumen, on Quartz calc. Sand R'k	1	Herkimer Co., N. Y.		
1691	"	"	"Mica, magnetited"	1	New Hampshire		
1692	"	"	Galenite	1	Colorado		
1693	"	"	Sphalerite (Blende)	2	Phœnixville, Pa.		
1694	"	"	Tourmaline	6	Chester, Mass.		
1695	"	"	Celestite	1	Mt. Gergenti, Sicily		
1696	"	"	Quartz (Amethyst) and Fluorite	1	England		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1697	Nov. 1876	Geo. F. Kunz	Halite	4	St. Martinsville, La.		
1698	"	"	Halite	1	Utah Territory		
1699	"	"	Limonite after Pyrite	1	Pennsylvania		
1700	"	"	Sphalerite [Blende] and Galenite on Quartz	1			
1701	"	"	Gypsum [Selenite]	1	Cayuga Lake, N. Y.		
1702	"	"	Barite	1	Gibralter		
1703	"	"	Calcite]Calc Tufa]	1	Litchfield, N. Y.		
1704	"	"	Allanite	5	Franklin, N. J.		
1705	"	"	Jefferisite	4	Westchester,Ch'r Co.Pa		
1706	"	"	Muscovite	2	Jefferson Co. N. Y.		
1707	"	"	Jeffersite	2	Connecticut		
1708	"	"	Serpentine	1	Pennsylvania		
1709	"	"	Chalcocite [Sulphide of Copper] after Wood	1	New Mexico		
1710	"	"	Azurite and Malachite	1	"		
1711	"	"	Gypsum	1	Dubuque, Iowa		
1712	"	"	Amphibole [Tremolite] in Dolomite	2	Lee, Mass.		
1713	"	"	Garnet	1	Hanover, N. H.		1
1714	"	"	Strontianite	1	England		
1715	"	"	Magnesite [White, Compact]	1	Hoboken, N. J.		
1716	"	"	Malachite	3	Chili, S. A.		
1717	"	"	Gypsum [Alabaster]	1	Cape Breton, N. S.		
1718	"	"	Green Tourmaline	1	Paris, Maine		
1719	"	"	Limonite	1	Chestnut Hill,LanCo Pa		
1720	"	"	Calcite ["Rock Milk"]	1	Watertown, N. Y.		
1721	"	"	Gothite [Lepidocrocite]	1	Chestnut Hill, Pa.		
1722	"	"	Aragonite, "Mexican Onyx"	1	Mexico		
1723	"	"	Stilpnomelane [Chalcodite]	1	Sterling MineAnw'pNY		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1724	Nov. 1876	Geo. F. Kunz	Ægirite (Black)	1	40 mile w Mag. Cove, Ark		
1725	"	"	Euxenite	1	Norway		
1726	"	"	Embolite	1	Silver City, Colorado		The "Bogus Silver Ore" from Western Boulevard and 105 st. N. Y. City caused great excitement
1727	"	"	Pyrite in Gneiss	1	New York City		
1728	"	"	Rhodonite (Fowlerite)	1	Franklin, N. J.		
1729	"	"	Chabazite (White)	1	Ausig, Bohemia		
1730	"	"	Anorthite (Indianite)	2	Chester, Mass.		
1731	"	"	Limonite (Bog Iron Ore, after Wood)	1	New York State		
1732	"	"	Calcite (Fibrous Carb. of Lime)	2	Chicopee, Mass		
1733	"	"	Fluorite	1	Derbyshire England		
1734	"	"	Porphyry [dite	1	Spain		
1735	"	"	Cassiterite Fluorite and Lepidolite (Zinnwal-	1	Paris, Maine		
1736	"	"	Fetid Limestone	1	Massachusetts		
1737	"	"	Albite	2	New York City		
1738	"	"	Berthierite	1	Havunge, Depar't of the Mosselle, France		
1739	"	"	Malachite	1	New Mexico		
1740	"	"	Prehnite	1	Tyrol		
1741	"	"	Serpentine (Williamsite)	1	Pennsylvania		
1742	"	"	Calcite (Dog-Tooth Spar) [domelane	1	Bergen Hill, N. J.		
1743	"	"	Cancrinite with Torbernite (Chalcolite) Lepi-	3	Litchfield, Me.		
1744	"	"	Triphylite	1	Grafton, Vt.		
1745	"	"	Titanite (Sphene, Lederite)	1	New York		
1746	"	"	Titanite (Lederite)	2	Franklin, N. J.		
1747	"	"	Limonite coating Pyrite	1	Pennsylvania		
1748	"	"	Phlogopite	1	Canada		
1749	"	"	Samarskite	1	North Carolina		
1750	"	"	"Zonochlorite"	1	Hudson Bay Territory		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1751	Nov. 1876	Geo. F. Kunz	Celestite on Sulphur	3	Mt. Girgenti, Sicily		
1752	"	"	Cryolite, Sphalerite and Pyrite	1	Ivigtut, Greenland		
1753	"	"	Garnet	1	New York City		
1754	"	"	Covellite	1	Chili		
1855	"	"	Asphaltum	1	Egypt		[furnace.
1756	"	"	Fluorite [Fluate of lime]	2	Columbia, Pa.		In Furnace Slag, St. Charles
1757	"	"	Amphibole [Tremolite]	1	Hartz, Germany		
1758	"	"	Brucite	2	Hoboken, N. J.		Of rare occurrence at Hoboken
1759	"	"	Vanadinite	1	Lead Hills, Scotland		
1760	"	"	Pyrite	2	England		
1761	"	"	Gypsum, [Selenite, single crystal.]	1	Paris, France		
1762	"	"	Gypsum, [Selenite, twin crystals]	1	" "		
1763	"	"	Vesicular lava with chrysolite	1	Sandwich Islands		
1764	"	"	"Carbonite."	1	Near Richmond. Va.		
1765	"	"	Peganite	2	Near Hot Springs, Ark.		
1766	"	"	Genthite on Chromite.	1	Wood's mine Lanc'r Co.		
1767	"	"	Blue Calcite [clane.	1	Lake Champlain [Pa.		
1768	"	"	Cancrinite with Nephelite [Elæolite] Lepidom-	1	Litchfield, Me		
1769	"	"	Prehnite	1	Simsbuby, Conn.		
1770	"	"	Opal [Hyalite]	1	England		
1771	"	"	Calcite [Satin Spar]	1	Chicopee, Mass.		
1772	"	"	Limonite ["Pipe Ore."	2	Near Easton, Pa.		
1773	"	"	Hollowed Analcite	1	Bergen Hill, N. J. [Md.		
1774	"	"	Schistose Hematite	1	Bachman Val.Carrol Co.		
1775	"	"	Pyroxene [Augite] in Lava	1	Vesuvius, Italy		
1776	"	"	Margarodite	1	Chester, Mass		
1777	"	"	"From a zinc furnace"	1	Virginia		Forty per cent. zinc

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1778	Nov. 1876	Geo. F. Knnz	Melaconite (Tenorite)	1	Chili		
1779	"	"	Siderite (Sphero siderite)	1	New York City		
1780	"	"	Samarskite	1	North Carolina		Crystal
1781	"	"	Mimetite (Campylite)	1	Dry gill, England		
1782	"	"	Hubnerite	1	California		
1783	"	"	Celestite	1	Magnet Cove, Ark		
1784	"	"	Tourmaline and oligoclase	2	Green Island, Lake Erie		
1785	"	"	Dolomite (Pearl spar) with Fluorite,	1	New York City		
1786	"	"	Grey Tephroite, Franklinite and zincite	1	Lockport, N. Y		
1787	"	"	Quartz (Chalcedony)	1	Franklin, N. J		
1788	"	"	"Jade"	1	Italy		
1789	"	"	Pyromorphite on quartz	1	Easton, Pa		
1790	"	"	Elaterite (Elastic Bitumen)	3	Phœnixville, Pa		
1791	"	"	Black Garnet containing schorlomite	1	Derbyshire, Eng		
1792	"	"	Radiated gypsum	1	Marseilles, France		
1793	"	"	Menaccanite in talc	1	Harford Co. Md		
1794	"	"	Quartz (Jasper)	1	Massachusetts		
1795	"	"	Talc	1	St. Lawrence Co., N. Y.		
1796	"	"	Serpentine and Calcite (Argentine)	1	Montville, N. J		
1797	"	"	Enargite	1	Alpine Co., Cal		[Plaster of Paris came.
1798	"	"	Gypsum	1	Paris, France		Quarry from which the name
1799	"	"	Hydrodolomite	1	Westchester Co., N. Y		
1800	"	"	Phrenite	1	Lake Superior		
1801	"	"	Arsenic (native)	1	Germany		
1802	"	"	Vivianite	1	Monmouth Co., N. J		
1803	"	"	Wolframite (pseudo after Scheelite)	1	Connecticut		
1804	"	"	Calcite (Stalactite)	1	Dubuque, Iowa		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1805	Nov. 1876	Geo. F. Kunz	Quartz	2	Magnet Cove, Ark		
1806	"	"	Amphibole (Actinolite)	1	Holliston, Mass		
1807	"	"	Fluorite	1	Hardin Co., Ill		
1808	"	"	Sphalerite [Blende, showing cleavage]	1	Granby, Mo		
1809	"	"	Mineral Coal [Lignite Coal	1	Isthmus of Panama		
1810	"	"	Tourmaline [Indicolite] and Beryl [Goshenite]	1	Goshen, Mass		
1811	"	"	Witherite [radiated]	1	Newcastle, Eng		
1812	"	"	Chalcocite	1	Liberty Mine, Md		
1813	"	"	Dolomite [Pearl Spar]	1	Lancaster Co., Pa		
1814	"	"	Lesleyite	1	Newlin, Chester Co., Pa		
1815	"	"	Amphibole [Amianthus]	1	Harford Co., Md		
1816	"	"	Zircon	7	Buncome Co., N. C		
1817	"	"	Pinite [Gieseckite]	1	Nat. Br'dg, Lewis Co. N. Y		
1818	"	"	"Porcelain Jasper"	1	Germany		
1819	"	"	Brookite [Arkansite, in quartz]	1	Magnet Cove, Ark		
1820	"	"	Zincite [Oxide of Zinc]	2	Franklin, N. J		From fused ore heap
1821	"	"	Green Wavellite	2	Hot Springs, Ark		
1822	"	"	Pink Spinel in Pyroxene [Sahlite]	1	Vernon, N. J		
1823	"	"	Adamite	1	Toulon, France		
1824	"	"	Pyroxene	1	Northern, N. Y		
1825	"	"	Radiated Ripidolite	2	New York City		
1826	"	"	Aragonite	1	Mt. Girgenti, Sicily		
1827	"	"	Brucite	1	Wood's Mine, Lan co. Pa		
1828	"	"	Azurite and Malachite	3	Franklin, N. J		
1829	"	"	Pyromorphite	8	Phœnixville, Pa		
1830	"	"	Magnetite (magnetic iron sand)		Long Island Beach		
1831	"	"	Magnetite	5	Near Stockholm, N. J		Ogden mine

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1832	Nov. 1876	Geo. F. Kunz	Magnetite	3	Near Bloomington, N. J		
1833	"	"	Magnetite	3	Roseville, N. Y		
1834	"	"	Magnetite	1	Byrain, N. J		
1835	"	"	Magnetite	1	New Jersey		
1836	"	"	Magnetite	2	Woodsport, N. J		
1837	"	"	Magnetite	12	Franklin, N. J		
1838	"	"	Stibnite	3	Hungary		
1839	"	"	Petrified wood	1	Middle Park, Col		
1840	"	"	Petrified wood	1	Colorado		
1841	"	"	Petrified wood	1	Colorado		
1842	"	"	Siderite (Carbonate of Iron)	1	New York City		
1843	"	"	Asphaltum	1	Bex, Switzerland		
1844	"	"	Mineral Coal (Lignite) with Pyrite	1	Ohio		
1845	"	"	Result of decomposition of Pyrite	1	Bergen Hill, N. J		
1846	"	"	Tourmaline (bent crystals)	1	Cecil Co., Md		
1847	"	"	Chromite	1	Wood's mine, Lan. co. Pa		
1848	"	"	Cryolite with Siderite	1	Arksut Bay, Greenland		
1849	"	"	Cyanite	2	Newton, Conn		
1850	"	"	Limonite	10	Hamburg, N. J		
1851	"	"	Pyrite	1	Bergen Hill, N. J.		
1852	"	"	Galenite	1	Phœnixville, Pa		
1853	"	"	Magnetite	1	Dickinson Mine, N. J		
1854	"	"	Anthophyllite	1	Smithfield, R. I		
1855	"	"	Allanite (Orthite, crystals)	2	New York City		
1856	"	"	Ripidolite (Chlorite)	1	Franklin, N. J		
1857	"	"	Amphibole (Byssolite) and Ægirite	1	Hot Springs, Ark		
1858	"	"	Gothite (Feathery Lepidocrocite)	2	Chestnut Hill, Pa		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained.		Name.	No. of Specimen.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1859	Nov. 1876	Goe. F. Kunz	Serpentine	1	Franklin, N. J		
1860	"	"	Stilbite resembing Wavellite	1	Philadelphia. Pa		
1861	"	"	Aragonite	1	Franklin, N. J		
1862	"	"	Garnet (Colophonite) and Rhodonite (Fowlerite) Crystals	1	"		
1863	"	"	Brown Hematite	2	Friedensville, Pa		
1864	"	"	Calamine	1	"		
1865	"	"	Epidote on Orthoclase	1	New York City		
1866	"	"	"Scapolite"	1	Lewis Co. N. J		
1867	"	"	Brookite	2	Arkansas		
1868	"	"	Native Copper	1	Marqueette Co. Mich		
1869	"	"	Calamine	1	Bethlehem, Pa		
1870	"	"	Magnesite (Brennerite)	1	Massachusetts		
1871	"	"	Limonite and Smithsonite	1	Franklin, N. J		
1872	"	"	Niccoliferous Pyrrhotite	1	Lancaster Co. Pa		
1873	"	"	Calcite (Argentine) and Serpentine	1	Montville. N. J		
1874	"	"	Enstatite (Bronzite)	1	Texas, Lancaster Co. Pa		
1875	"	"	Ægirite	1	Hot Springs, Ark		
1876	"	"	Hydromagnesite	3	Lancaster Co., Pa		
1877	"	"	Jadeite	2	Easton, Pa		
1878	"	"	Domeykite	1	Chili, S. A		
1879	"	"	Copper in calcite	1	Lake Superior		
1880	"	"	Hydrodolomite (Pennite)	1	Lancaster Co. Pa		
1881	"	"	Ripidolite (Clinochlore)	1	Franklin, N. J		
1882	"	"	Witherite on Water Lime	7	Rondout, N. Y		Only American locality
1883	"	"	Barite, Malachite and Quartz	1	Cheshire, Ct		
1884	"	"	Manganite	1	Nova Scotia		
1885	"	"	Malachite in Ochre	1	Maryland		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1886	Nov. 1876	Geo. F. Kunz	Flesh-colored Quartz Rock	1	Burlington, Vt.		
1887	"	"	Pele's Hair	Indf	Sandwich Islands		
1888	"	"	"Mica"	3	Franklin, N. J.		
1889	"	"	Datolite (Oil green variety)	1	Bergen Hill, N. J.		
1890	"	"	Prehnite with vein of "Stevensite"	1	"		
1891	"	"	Gœthite (Lepidocrocite)	1	Chestnut Hill, Pa.		
1892	"	"	Tourmaline	1	Chester, Mass.		
1893	"	"	Red Hematite	1	Franklin, N. J.		
1894	"	"	Graphite	35	New Jersey		
1895	"	"	Arsenopyrite (Mispickel)	1	Roxbury, Ct.		
1896	"	"	Dendrite	1	Franklin, N. J.		
1897	"	"	Feldspar on Trap	1	Bergen Hill, N. J.		
1898	"	"	Gold in Quartz	1	California		
1899	"	"	Seybertite (Clintonite) and Chalcopyrite	1	Franklin, N. J.		
1900	"	"	Epidote, Orthoclase and Copper	1	Lake Superior		
1901	"	"	Siderite	1	England		
1902	"	"	Fluorite	1	Mine Hill, Franklin, N. J.		
1903	"	"	Penninite	1	Lows Mine, Tex. Lan. Co		Lows Mine
1904	"	"	Green Quartz	1	Staten Island N. J. [Pa		
1905	"	"	Zircon on Feldspar	1	Diana N. J.		
1906	"	"	Magnesite	1	Hoboken N. J.		
1907	"	"	Sodalite	1	Salem, Mass. [N. J.		
1908	"	"	Willemite	1	Passaic Mine, Franklin,		
1909	"	"	Orthoclase and Epidote	1	New York City		
1910	"	"	"Mica"	1	Chesterfield, Mass.		
1911	"	"	Aragonite	2	Franklin, N. J.		
1912	"	"	Turgite (Hydrohematite)	2	Chestnut Hill, Pa.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1913	Nov. 1876	Geo, F. Kunz.....	Pectolite and Datolite	1	Bergen Hill, N. J.	....	....
1914	"	"	Goethite (Lepidocrocite)	1	Chestnut Hill, Pa.	....	....
1915	"	"	Magnetite (Native magnet)	1	Union Town, N. J	....	....
1916	"	"	Ruby zinc, Dialogite and "Sussexite"	1	Franklin, N. J	....	....
1917	"	"	Brookite (Arkansite)	1	Magnet Cove, Ark	....	....
1918	"	"	Apophyllite and Stilbite	1	Bergen Hill, N. J	....	....
1919	"	"	Apophyllite and Datolite	2	" "	....	....
1920	"	"	Apophyllite (modified)	1	" "	....	....
1921	"	"	Laumontite	2	" "	....	....
1922	"	"	Titanite (Sphene)	1	Amity, N. Y.	....	....
1923	"	"	Tourmaline	1	....	....	....
1924	"	"	Fossiliferous Hematite	1	Oneida, N. Y.	....	....
1925	"	"	Analcite, Apophyllite and Natrolite	1	Bergen Hill, N. J.	....	....
1926	"	"	Rhodonite	2	Cummington, Mass	....	....
1927	"	"	Muscovite	2	New Hampshire	....	....
1928	"	"	Rhodonite (Cummingtonite)	1	Cummington, Mass	....	....
1929	"	"	Chrysocolla and green quartz	1	Chili, S. A.	....	....
1930	"	"	Melanterite (native copperas)	1	Staten Island, N. Y.	....	From Iron mine
1931	"	"	Copper on quartz	1	Lake Superior, Mich	....	Central mine
1932	"	"	Garnet (Colophonite)	1	Franklin, N. J	....	....
1933	"	"	Quartz (Silicified wood)	1	Southern Georgia	....	Not found in any other local-
1934	"	"	Wenerite (Lilac Scapolite)	1	Bolton, Mass.	....	ity and not described in the
1935	"	"	Garnet ....[stone.	1	New Jersey	....	books. Very handsome when
1936	"	"	Calcite (concretionary marble) on fetid lime-	1	Holyoke, Mass	....	polished across the cut of the
1937	"	"	"Montebrasite."	1	Montebras, Creiese Fr.	....	concretions.
1938	"	"	Gold and Silver ore ....[spar.)	1	East Creek, N. J	....	Belden's Mine.
1939	"	"	Calcite (dog-tooth spar) and Dolomite (Pearl	1	Lockport N. Y.	....	....

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
1940	Nov. 1876	Geo. F. Kunz	Datolite (in small crystals)	1	Bergen Hill, N. J.		
1941	"	"	Lepidolite	1	Alterberg, Saxony		
1942	"	"	Calcite	1	Warwick, N. Y.		
1943	"	"	Slag from Furnace	1	Patterson, N. J.		
1944	"	"	Calcite	1	Bellville, N. J.		From old copper mine.
1945	"	"	Iridescent Pyrite	1	Scales Mound, Galena Ill		
1946	"	"	Amphibole (actinolite)	1	Black Horse, Del.		
1947	"	"	Amphibole (actinolite)	2	63rd St. New York City.		
1948	"	"	Orthoclase (Amazon stone)	1	Mineral Hill, Pa.		
1949	"	"	Calcite, Pyrite and Specular iron	1	Antwerp, N. Y.		
1950	"	"	Amygdaloid containing zeolites	1	Poonah. Hindostan		
1951	"	"	Gangue rock of Cassiterite (Tinstone)	1	Durango, Mexico		
1952	"	"	Opal	1	Rocky Mountains		
1953	"	"	Sphalerite (with Bitumen and Galenite)	1	Oronogo, Mo.		
1954	"	"	Topaz (yellow)	1	Brazil, S. A.		
1955	"	"	Quartz coated with Smithsonite (carb of zinc.)	1	Chatham. N. Y.		
1956	"	"	Opal	1	Mexico		
1957	"	"	Apophyllite	1	Bergen Hill, N. J.		Changing to Thomsonite.
1958	"	"	Staurolite	1	Lisbon, N. Hampshire		
1959	"	"	Chrysolite (Olivine)	1	Dries Eifel, Europe		
1960	"	"	Quartz	1	Governeur, N. Y.		Without lateral planes,
1961	"	"	Quartz	1	Antwerp, N. Y.		Without lateral planes.
1962	"	"	Topaz (pink)	1	Brazil, S. A.		
1963	"	"	Gold	1	Virginia		
1964	"	"	Siderite and quartz in Geode....[Specular iron.	1	Illinois		
1965	"	"	Quartz without lateral planes and Hematite,	1	Cumberland, Eng.		
1966	"	"	Quartz and chalcopyrite	1	Ellenville, N. J.		

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Seiral Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
1967	Nov. 1876	Geo. F. Kunz	Calcite (Dog-tooth Spar)	1	Rossie, N. Y		Doubly terminated
1968	"	"	Pectolite	3	Bergen Hill, N. J		Friable
1969	"	"	"Zonochlorite"	4	Hud. Bay Co., Ter. B. A.		
1970	"	"	Cryst. Samarskite with Xenotime	1	North Carolina		
1971	"	"	Smithsonite and Sphalerite (Blende)	1	Bethlehem, Pa		
1972	"	"	Graphite	2	Ticonderoga, N. Y		
1973	"	"	Wad	1	Near Franklin, N. J		
1974	"	"	"Stevensite," Datolite and Natrolite	1	Bergen Hill, N. J		
1975	"	"	Sphalerite (Blende)	2	Oronogo, Mo		Showing cleavage
1976	"	"	Amphibole (Asbestus)	1	Staten Island		
1977	"	"	Serpentine (Picrolite)	1	Franklin, N. Y		
1978	"	"	Serpentine (Picrolite)	2	Roseville, N. J		
1679	"	"	Calcite (Stalactite)	1	Mammoth Cave, Ky.		
1980	"	"	Opal (Cacholong)	10	Georgia		
1981	"	"	Cyanite (Rhætizite)	1	Germany		
1982	"	"	"Chrome Sand"	Ind	Media, Pa		
1982	"	"	Quartz	4	Gouverneur, N. Y		Without lateral planes
1984	"	"	Chlorastrolite	Ind	Isle Royale, Lake Sup.		
1985	"	"	Quartz (Carnelian)	1	Germany		
1986	"	"	Corundum (Emery)	2	Chester, Mass		
1987	"	"	Galenite	4	Oronogo, Mo		
1988	"	"	Galenite	1	Oronogo, Mo		
1989	"	"	Cuprite	8	Chessy, France		
1990	"	"	Andalusite (Chiastolite, or Macle)	1	Massachusetts		
1991	"	"	Gold Quartz	1	California		
1992	"	"	Tephroite	4	Franklin, N. J		
1993	"	"	Silver and Gold	1	Colorado		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Whence.					
1994	Nov. 1876	Geo. F. Kunz	Magnetite (Loadstone)	75	Magnet Cove, Ark		
1995	"	"	Magnetite (Sand)	1	Port Ontario, N. Y		
1996	"	"	Brown Garnet and Iron Garnet on Pyroxene (Jeffersonite)	1	Franklin, N. J		
1997	"	"	Orthoclase (Chesterlite)	1	Chester Co., Pa		
1998	"	"	Gypsum (Selenite)	1	Lockport, N. Y	Niagara group	
1999	"	"	Crystallized Pectolite	10	Bergen Hill, N. J.		
2000	"	"	Laumontite and Crystallized Pectolite	3	Bergen Hill, N. J		Very rare
2001	"	"	Wulfenite	1	Tecoma Mine, Utah		
2002	"	"	Quartz (Yellow Jasper)	1	California		
2003	"	"	Calamine, Sphalerite and Greenockite	2	Granby, Mo		
2004	"	"	Chlorastrolite	2	Isle Royal, Lake Sup		Rare, in rock
2005	"	"	Sphalerite (Blende) and Quartz	1	Phœnixville, Pa		
2006	"	"	Black Tourmaline	1	Kingsbridge, N. Y. City		
2007	"	"	Zincite (with Calcite)	1	Franklin, N. J		
2008	"	"	Brucite (Nemalite)	1	Hoboken, N. J		
2009	"	"	Amphibole (Hornblende) in Quartz	2	Chester, Mass		
2010	"	"	Zaratite	1	Wood's Mine, Lan. co. Pa		
2011	"	"	Epidote	1	Massachusetts		
2012	"	"	Orthoclase (Flesh colored Feldspar)	2	New York City		
2013	"	"	Oligoclase	1	New York City		
2014	"	"	Seybertite (Clintonite)	1	Franklin, N. J		
2015	"	"	Zincite (with Calcite) "Sussexite"	1	Franklin, N. J		
2016	"	"	Greenockite	1	Granby, Mo		Of the following Nos. to No. 2063,
2017	"	"	Siderite	1	Roxbury, Conn		nearly all were collected by
2018	"	"	Gmelemite	1	Bergen Hill, N. J		[Chas. Clifton, about 1860, from
2019	"	"	" Feldspar"	1	Chester, Pa		near Easton, Pottsville, and the
2020	"	"	Limonite	24	Near Easton, Pa		coal and iron district bordering.

Catalogue of Specimens Registered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2021	Nov. 1876	Geo. F. Kunz	Limonite [Fibrous]	5	Near Easton, Pa.		
2022	"	"	Limonite	9	PompeysMarsh nr E'st'n		
2023	"	"	Limonite [Stalactitic]	1	Easton, Pa.		
2024	"	"	Limonite	4	Franklin, N. J		
2025	"	"	Limonite	2	Pottsville, Pa.		
2026	"	"	Limonite	4	Altoona Pa		Alleghany Furnace
2027	"	"	Limonite	5	Chestnut Hill, Pa.		
2028	"	"	Limonite	2	Bennington Furnace,Pa		
2029	"	"	Limonite [Septaria of]	1	Hopewell, Pa.		
2030	"	"	Limonite [fossil]	2	Bedford, B. Co. Pa.		
2031	"	"	Limonite [fossil]	3	Hopewell, Pa.		
2032	"	"	Limonite [fossil]	1	Columbia Co. Pa.		
2033	"	"	Limonite [fossil]	1	Near Altoona, Pa.		
2034	"	"	Hematite [Red]	3	Near Easton, Pa.		
2035	"	"	Hematite [brown]	3	Pompey's Marsh, Pa.		
2036	"	"	Hematite [brown]	2	Bennington Furnace,Pa		
2037	"	"	Hematite [fossil]	1	Near Easton, Pa.		
2038	"	"	Hematite [fossil]	12	Brush Hill, Pa.		
2039	"	"	Hematite [fossil]	1	Henry Furnace, Pa.		
2040	"	"	Hematite [fossil]	2	Bennington Furnace,Pa		
2041	"	"	Hematite [fossil]	3	Altoona, Pa.		
2042	"	"	Hematite [fossil]	1	Lewiston, Pa.		
2043	"	"	Hematite [fossil]	1	Mt. Savage, Pa		Camberland Furnace
2044	"	"	Hematite	1	Danville, Pa		
3045	"	"	Siderite	4	Hopewell Furnace, Pa.		
2046	"	"	Siderite [Shale]	1	Trantbree Tunnell, Pa.		
2047	"	"	Siderite and Limonite	1	Hopewell Furnace, Pa.		

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Catalogue of Specimens Rigistered in the General Museum in 1877—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2048	Nov. 1877	Geo. F. Kunz	Siderite	1	Hopewell, Pa.		23 Siliceous
2049	"	"	Siderite	2	Easton, Pa.		
2050	"	"	Hematite (Specular Iron)	2	Lake Superior Region.		
2051	"	"	Hematite (Specular Iron)	1	Near Pottsville, Pa.		
2052	"	"	Hematite (Specular Iron)	2	Near Easton, Pa.		
2053	"	"	Hematite (Specular Iron)	1	Pottsville, Pa.		
2054	"	"	Pipe Ore	1	Pottsville, Pa.		Bay Ridge Mountain Coal Field
2055	"	"	Calcite and Siderite	1	Easton Pa.		
2056	"	"	Magnetite	4	Mt. Hope, N. J		
2057	"	"	Magnetite	2	Dover, N. J		
2058	"	"	Magnetite (Magnetic Iron)	1	Cornwall, Leban'n co Pa		
2059	"	"	Magnetite and Pyrite	2	" "		
2060	"	"	Magnetite and Pyrite	1	" "		
2061	"	"	Pyrite	1	Near Easton, Pa.		
2062	"	"	Magnetite ?	3	Cornwall, Leban'n co Pa		
2063	"	"	Iron Ore	1	Bedford county, Pa.		
2064	"	"	Sodalite with Cancrinite and Lepidomelane	1	Litchfield, Me.		
2065	"	"	Peculiar Slags from Furnaces	2	Alleghany, Pa.		Same Note Applies as to No. 2020
2066	"	"	Calcite (Flux)	1	Easton, Pa.		" " " " 2020
2067	"	"	Slag Crystals from Furnaces	1	Easton, Pa.		" " " " 2020
2068	"	"	Mineral Coal (Anthracite)	2	Pottsville, Pa.		" " " " 2020
2069	"	"	Beryl (Aquamarine)	1	Liberia		
2070	"	"	Cassiterite (Stream Tin) and Topazes	Indf	Durango, Mexico		
2071	"	"	Cassiterite (Stream Tin)	Indf	Durango, Mexico		
2072	"	"		1			Believe it Artifi. (G. F. K.) As 2020
2073	"	"	Siderite (Carb. of Iron, Shale	2	Mt. Savage, Pa.		Same Note Applies as to 2020
2074	"	"		1	Summit Furnace, Pa.		" " " 2020

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2075	Nov. 1876	Geo. F. Kunz	"Fire Clay"	2	Mt. Savage, Pa		Same note applies as to 2020
2076	"	"	Coal Shale	1	Pottsville, Pa		Same note as 2020, about 400 feet above main view
2077	"	"	Limestone Ore (No. 1)	1	"		The following six are from a mine near Pottsville
2078	"	"	"Slate Pins" (No. 2)	1	"		About 4 feet above main vein
2079	"	"	"Sandy Pin" (No 3)	1	"		" 31 " "
2080	"	"	"Lime Pin" (No. 4)	1	"		" 20 " "
2081	"	"	"Upper Bastard (No. 5)	1	"		" 17 " "
2082	"	"	"Pin Vein of Ore'. (No. 6)	1	"		" 17 " "
2083	"	"	(No. 7)	1	"		With 4 fluid cavities marked with
2084	"	"	Quartz	1	Near Hot Springs, Ark		[ink.
2085	"	"	Calamine (blue)	2	Franklin, N. J		Crystal showing "O plane" of
2086	"	"	Calcite	1	Bergen Hill, N. J		[Dana
2087	"	"	Microlite and Uraconite (Uranochre)	1	North Carolina		
2088	"	"	Chloritoid (Masonite)	1	Smithfield, L. Island		
2089	"	"	Apatite, Pyrite and Graphite	1	Franklin, N. J		
2090	"	"	Quartz and Epidote	1	" "		
2091	"	"	Calcite coated with quartz (Chalcedony)	1	Bergen Hill, N. J		
2092	"	"	Decomposing Pectolite and Prehnite	1	" "		
2093	"	"	" Chalcopyrite	1	" "		
2094	"	"	Pseudo Talc (Steatite)	1	" "		
2095	"	"	Franklinite and Calcite	2	Franklin, N. J		
2096	"	"	Franklinite and Calamine	1	" "		
2097	"	"	Wernerite (Scapolite) and Apatite	1	" "		
2098	"	"	Oligoclase	1	New York City		
2099	"	"	Amphibole (Asbestus)	5	Franklin, N. J		
2100	"	"	Labradorite	1	Louis County, N. Y		
2101	"	"	Graphite and some other mineral	1	New York		

Catalogue of Specimens Registered in the General Museum in 1877.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2102	Nov. 1879	Geo. F. Kunz	Catlinite	1	Pipestone Co., Minn.		
2103	"	"	Quartz containing fluid and mineral coal (Anth.)	1	Herkimer Co., N. Y.		
2104	"	"	Barite	1	Franklin, N. J.		
2105	"	"	Spodumene	1	Maine		
2106	"	"	Zincite and Calcite Spartaite	1	Franklin, N. J.		
2107	"	"	Garnet on Zincite (Schist)	4	Franklin, N. J.		
2108	"	"	Franklinite, Zincite and Calcite (Spartaite)	1	Franklin, N. J.		
2109	"	"	"Mica"	1	Chester, Pa.		
2110	"	"	Pyrite (octahedral)	2	Bergen's Hill, N. J.		
2111	"	"	Quartz (Amethyst, doubly terminated)	6	Brazil		
2112	"	"	Perofskite	4	Magnet Cove, Ark.		
2113	"	"	Pyroxene (in lava)	15	Vesuvius, Italy		
2114	"	"	Brucite	2			
2115	"	"	Calcite (Stalactite)	2			
2116	"	"	Serpentine	1	St. Lawrence Co., N. Y.		
2117	"	"	Calamine on Sphalerite	1	Granby, Mo.		

INDEX TO THE GEOLOGICAL REPORT.

ERRATA.

On page 3, insert "the" before Geological.
On page 3, for "Dec. 31, 1877," read May 25, 1878.
On page 27, fifth line from top, for "lining" read limy.
On page 28, first line from top, for "6.44" read 6.21.
On page 28, first line from top, for "32.287" read 31.287.
On page 28, second line from top, last column in table, for "0" read 9.
On page 43, for "Reconnoisences" read Reconnoissances.
On page 48, eighth line from bottom, for "moutone-ed" read *moutonne-ed*.
On page 53, second line from bottom, for "scantly" read scantily.
On page 55, third line from bottom, for "60" read 27.
On page 59, twelfth line from bottom, for "nolithic" read neolithic.
On page 68, third line from the top, for "Thus" read This.
The 69th and 70th pages should exchange places.
On page 75, at bottom, add Ilex verticellata, *Gray*, Black alder.
On page 82, fourteenth line from top, for "Chæteets" read Chætetes.
On page 83, twenty-fourth line from the bottom, for "organized" read recognized.
On page 99, seventeenth line from bottom, for "southwestern" read southeastern.
On page 123, third line from top, for "exposuse" read exposure.
On page 123, sixth line from top, for "mills" read miles.
On page 129, fourth line from bottom, for "62" read 52.
On page 201, strike out "Rock on which Duluth is built."
On page 216, the words "with 4 fluid cavities marked with ink," and "crystal showing 'o plane of Dana," should each be placed a line lower on the page.

THE GEOLOGICAL

AND

NATURAL HISTORY SURVEY,

OF

MINNESOTA.

THE SEVENTH ANNUAL REPORT.

FOR THE YEAR 1878.

OFFICERS OF THE SURVEY.

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S. F. PECKHAM,	Chemistry.
M. D. RHAME,	Topography.
C. W. HALL,	Assistant Geologist.
P. L. HATCH,	Ornithology.
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CLARENCE L. HERRICK,	Laboratory Assistant.

Submitted to the President of the University Dec. 31, 1878.

MINNEAPOLIS:
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Pres.

J. C. Russell

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DAVID BURT, Superintendent of Public Instruction, St. Paul.
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STATE PUBLICATIONS RELATING TO THE GEOLOGY OF MINNESOTA.

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1. *Sketch of the Lead Region, by Dr. D. F. Weinland, with a statement of the objects of a geological and natural history survey. 34 pp. 1860. Reprint from the Wisconsin Reports for 1858. Out of print.*
2. *Statistics and History of the Production of Iron, by A. S. Hewitt. 47 pp. 1860. Reprint of a paper read before the American Geographical and Statistical Society, January 31, 1856. Out of print.*
3. *Report of Anderson and Clark, Commissioners on the Geology of the State, January 25, 1861. 8vo. 26 pp. Out of print.*
4. *Report of Hanchett and Clark, November, 1864. 8vo. 82 pp. Out of print.*
5. *Report of H. H. Eames, on the Metalliferous Region bordering on Lake Superior, 1866. 8vo. 23 pages.*
6. *Report of H. H. Eames, on some of the northern and middle counties of Minnesota. 1866. 8vo. 58 pp. Out of print.*
7. *Report of Col. Charles Whittlesey on the Mineral Regions of Minnesota. 1866. 8vo. 52. pp. close type, with wood cuts.*
8. *Report of N. C. D. Taylor on the Copper District of Kettle river, incorporating Mr. James Hall's estimate of the copper prospects of that district, 1866. 2. pp. 8vo. Found only in the Executive Documents.*
9. *Report of a Geological Survey of the vicinity of Belle Plaine, Scott county, Minnesota. A. Winchell. June 17, 1871. 8vo. 16 pp.*
10. *The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp. with a colored geological map of the state. Published in the Regents' Report for 1872. Out of print.*
11. *The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.*
12. *The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo. with two county maps. Published in the Regents' Report for 1874.*
13. *The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington; 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.*
14. *The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson; 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.*
15. *The Sixth Annual Report on the Geological and Natural History Survey, for the year 1877. By N. H. Winchell, with reports on Chemical Analyses by Prof. Peckham, on Ornithology by P. L. Hatch, on Entomology by Allen Whitman, and on the Geology of Rice county by L. B. Sperry; three geological maps and several other illustrations. Also published in the Regents' report for 1877.*

MISCELLANEOUS PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

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1. CIRCULAR NO. 1. *A copy of the law ordering the survey, and a note asking co-operation by citizens and others. 1872.*

2. PEAT FOR DOMESTIC FUEL, 1874. *Edited by S. F. Peckham.*

3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. *A history of all official transactions relating to them, and a statement of their amount and location. 1874. By N. H. Winchell.*

4. A CATOLOGUE OF THE PLANTS OF MINNESOTA; *prepared in 1865 by Dr. I. A. Lapham, contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.*

5. CIRCULAR NO. 2. *Relating to Botany, and giving general directions for collecting information on the flora of the State. 1876.*

6. CIRCULAR NO. 3. *The establishment and organization of the Museum. 1877.*

7. CIRCULAR NO. 4. *Relating to duplicates in the Museum and exchanges. 1878.*

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN.,
December 31, 1878.

To the President of the University:

DEAR SIR—I have the honor to offer the Seventh Annual Report, as required by law, on the progress of the Geological and Natural History Survey of the State.

Very respectfully, your obedient servant,

N. H. WINCHELL.

REPORT.

I.

SUMMARY STATEMENT.

Before the beginning of the field-work for the year the Board of Regents took important action relating to the Geological and Natural History Survey of the State, intended to carry out some of the suggestions of the last report.

1st. The State Geologist was relieved from giving instruction in the University, and an assistant was appointed to discharge those duties.

2nd. The operations of the survey were transferred to the northern part of the State.

3d. The zoological and botanical investigations were ordered to be kept in abeyance or carried only so far as possible without much additional expense.

4th. The geological survey proper was ordered to be pushed as rapidly as possible, with a view to substantial completion in four years, and the publication of a couple of volumes of a final report, one on the northern part of the State with the necessary mineralogy, and one on the southern with the necessary paleontology.

5th. The annual reports on the geological work were ordered to be brief and synoptical, the details of the survey being reserved for final publication in a more substantial and creditable form.

In consequence of this action the following report is calculated to give but an outline of the progress of the survey during the year.

Mr. C. W. Hall, late of Leipzig, who was appointed an assistant on the survey, conducted an independent party in the northern part of the State during September and October, and his preliminary report on the same is herewith transmitted.

Professor Peckham's report on chemical work done for the survey, and on an expedition for assaying ores on the north shore of Lake Superior, is embraced in the following pages.

Dr. P. L. Hatch submits an annual statement of progress in ornithology.

Identifications of plants in the northern part of the State, and notes on the flora and forest of the same are contributed by Mr. B. Juni who was special botanical collector during a portion of the season of 1878.

Mr. C. L. Herrick, assistant in the laboratory, is engaged on a systematic examination of microscopic entomostraca inhabiting fresh waters in Minnesota. This he has prosecuted for more than a year, and he contributes to the survey the first results of his work.

The Museum report, accompanying this, shows recorded additions to the specimens, and increased facilities for exchanging and working up the material on hand.

The survey is under obligations to President John P. Ilsley, of the St. Paul and Duluth R. R. and Chas. F. Hatch, Superintendent of the Minneapolis and St. Louis R. R., for free transportation on those railroads respectively, and to McLennan and Morison of Duluth, Henry Mayhew, of Grand Marais, and N. T. Wilson and James Caldwell of Grand Portage, for various favors in organizing parties and transporting supplies and specimens.

II.

SKETCH OF THE WORK OF THE SEASON OF 1878.

Before entering on the field-work for the season of 1878, it was decided to give special attention to the economical mineral interests of the northern part of the State, and if necessary, to spend the whole summer in visiting and examining the mineral locations and workings that have been begun in that part of the State. This was published in several of the State papers. It was very soon discovered, however, that the general interest of mining in the State had been over-estimated, and that but very few persons were sufficiently enlisted to desire any examination, or to accompany any geological party to their claims; and in fact, that at the present time there is no actual mining being done at any place in the State. It was at but one point that the owner of any mineral location was found at work on his claim, though at a number of places shallow shafts for trial have been sunk, and at some, a considerable deep excavation has been done in previous years. Still, the original plan was carried out, and all mineral locations of which any information could be obtained, were examined, so far as they were embraced within the territory of the State, and several also in British territory. In addition to the examination of all known mineral locations, the geology proper of the northern part of the State has been carefully observed along some important lines, and about forty-five boxes of specimens have been collected. The work consisted in a careful examination of the coast line of Lake Superior from Duluth to Pigeon river, for geological and lithological data. This occupied the greater part of July and August. During September and October two independent parties were engaged. One was occupied in ascending some of the streams that enter Lake Superior, beginning with those most easterly, and the other in a trip along the international boundary line as far as Basswood lake; thence to Vermilion lake; thence, by the Embarrass river, to the St. Louis river. Descending the

St. Louis to its nearest point of approach to the Mississippi river, this party crossed over to the Mississippi, and descended it as far as Little Falls, in Morrison county, when floating ice and cold weather rendered it impossible to continue the descent by river. The details of these explorations will be given in working up the geology and and lithology of the State. Some of the salient results are given by Mr. Hall in his report accompanying this, and others may be grouped and stated as follows.

(a) *Geological Results.*

The trend, or strike, of the formations of the northern part of the State, north of Lake Superior, is more nearly east and west than has been supposed. Hence, they cross the coast line at an acute angle, the later formations being toward the south, and the older along the international boundary line. The igneous cupriferous series seems to overlie several formations unconformably, and to be interstratified with some of the later, and especially with a red, shaly sandstone.

The formations that compose the coast line, including the cupriferous rocks which are everywhere the most conspicuous, and for many miles constitute the only visible rock, seem to be something as follows, in descending order.

1. Metamorphic shales, sandstones and quartzyte. These are cut by dykes, and are interbedded with igneous rock. They prevail along the coast from Duluth, an undetermined distance northeastward, and are, perhaps, the formation that Sir W. E. Logan regarded the Quebec group, as they are associated with copper-bearing amygdaloids and traps.

2. Ferruginous and aluminous sandstones. These seem to be metamorphosed into a firm basaltiform red rock, as seen in the Palisades, and at other points. The sandstones may be seen at Black Point, interstratified with igneous rock.

3. A quartzose conglomerate, seen at the Great Palisades and on Portage Bay Island—probably more properly a part of No. 2.

4. The quartzytes and slates of Grand Portage Bay, and eastward to the termination of Pigeon Point.

5. The jasper, flint and iron-bearing belt of Gunflint lake and Vermilion lake, and of the Mesabi range.

6. The slates and shists which the Canadian geologists particularly designate Huronian.

7. The syenytes, granytes and other rocks that have been classed as Laurentian.

8. The igneous rocks, known as the Cupriferous Series.

The particular and local details of stratigraphy and lithology will be given in the final report, with many interesting descriptions of scenic geology. A few general statements, which seem to be warranted by the observations of the past season, will be added here respecting the foregoing formations, though liable to modifications by later examination.

While No. 1 is in contact with the cupriferous rocks, and interbedded with them, at Duluth and many miles northeastward, No. 2 is in contact with them at Baptism river, No. 3 at Grand Portage, and No. 4 on Pigeon Point. The formations Nos. 2 and 3 (or 2 only, in the absence of 3) lie probably unconformably on No. 4, and being generally soft compared with the others, have permitted the excavation of bays, such as Pigeon Bay, Wauswaugoning Bay, Grand Portage Bay, Deronda Bay, Cannon-ball Bay, Double Bay, Horse-shoe Bay, Good Harbor Bay, and the bay at Black Point; the points projecting eastwardly being the igneous dikes or overflows, or the harder parts of No. 4. West of Black Point the coast line is mainly on the strike of the lower parts of No. 1; and so to about Little Marais, where it begins to ascend in the beds of No. 1 to Baptism river, where the order is reversed by an outburst of the underlying Nos. 2 and 3 for a short distance, the hill-ranges inland here also approaching the coast. Still further west the coast is wholly occupied by No. 1, apparently with a zigzag crossing of the strike as the line of upheaval brought the hills nearer the coast or let them recede. The points and islands east of Grand Portage Bay are in No. 4, or the associated igneous rocks of No. 8.

Nos. 4, 5, 6 and 7 are probably all conformably arranged in succession, at least they have been so seen at places. Nos. 4 and 5 are closely associated, and perhaps the latter is but a local phase of the former, while Nos. 6 and 7 are as closely related, being conformably interbedded and stratified. No. 5 is conformable with No. 6 in the iron district along the southeastern side of Vermilion lake. There are evidences that the cupriferous beds, *i.e.* the trap rock that plays a great part in the geology of the entire region, once extended over parts of No. 6, and it now lies almost everywhere over No. 4. Indeed the quartzyte and slates of No. 4, with the overlying sheets of igneous rock, are the only rocks seen *in situ* between Pigeon Point and Gunflint lake. Along the north side of this lake No. 6 first appears in force on the boundary line. Where the quartzyte of Nos. 4 and 5 terminates, westwardly, the cupriferous series also terminates. It was only on some of the islands in Vermilion lake

that there were evidences of the former extension of the igneous rock over No. 6, in the second metamorphism of some of the talcose slates.

The hill-ranges in the northern part of the State, north of Lake Superior, are, in general, mono-clinals sloping toward the S. S. E. and having various dip. They are uniformly (so far as yet seen) capped with a great thickness of the cupriferous series, and are composed, at different points, of strata belonging to Nos. 1, 2, 3, and 4, but most conspicuously to No. 4. Their ranges are not direct and systematic, but there seems to be a great confusion of short mono-clinal uplifts, the fractures repeating themselves a great many times in the same formation. Thus a vast number of faults in the broken strata are produced, causing veins and mineral deposits, and furnishing a key to the mineral explorer in searching for valuable ores. The hills formed by these short mono-clinals present their perpendicular sides, formed by the breaking of the beds, toward the northwest, and their gradual slopes toward the lake. The outline of their summits, if viewed a little obliquely, is exactly expressed by the name that has been given them at one point near the shore of Lake Superior—Saw Teeth Mountains.

The Mesabi Heights, north of Lake Superior, are composed outwardly of drift materials—at least wherever they were examined—and the ridge seems to be a glacial moraine. It is probable that its position was determined, at least modified, by the prior existence of a rock barrier through some of its course, if not through the whole of it. Indeed toward the northeast, where it crosses the international boundary, the mono-clinal quartzyte hills and ranges are the principal features, and it is probable that the strike of the quartzyte formation (No. 4) which is the most enduring and at the same time the most conspicuous of the tilted formations above the Laurentian, roughly coincides with this moraine.

There is some evidence that the location of some of the important points of outflow of igneous matter was along the north and west of the coast, and not in the bed of Lake Superior. Some of the Canadian geologists, particularly Mr. Robert Bell, have supposed that the original volcanic crater, or escape-point of igneous matter, was in the valley of Lake Superior, and is now covered by its waters.* Whatever may be the evidence to that effect, there are also evidences of a movement of the trap toward Lake Superior. Large masses of feldspar rock, embraced in the trap, as boulders are embraced in the hardpan clay, have been carried from Carlton's peak, or from a range of hills south and west of it, toward the

*Geological survey of Canada. Report of 1872-73, p. 105.

east and southeast. These embraced pieces become smaller in going from their place of origin, in the same manner as fragments of rock acted on by the drift forces.

In regard to the mineralogy and lithology of the State north of Lake Superior, many interesting observations and collections have been made, but it would not be profitable nor possible to effect their elucidation till they have been studied and classified, and until full data have been gathered for their discussion.

(b) Economic Geology.

Preliminary field-report of mining and mining locations.

Of the foregoing formations, as No. 8, is known as the cupriferous series, or copper-bearing rocks, so No. 6 might be conveniently designated the auriferous, No. 5 the ferriferous, No. 4 the argentiferous. The cupriferous rocks i. e. the trap, overlies unconformably Nos. 4, 5, and 6, and is interstratified with Nos. 1, 2, and 3. It becomes specially cupriferous in contact with Nos. 1, 2, and 3. Not an instance is known of its bearing metallic copper when overlying Nos. 4, 5, and 6, within the limits of Minnesota.

COPPER.

This occurs in the cupriferous series in several forms, but particularly as native metal. This has been reported for several years, and some systematic attempts were made in 1863 and 1864, by the French River Mining Company,* to carry on mining for copper at French river, but for some reason the working ceased in 1864, and has not been resumed again. Metallic copper here occurs in a mineral that seems to run in irregular veins and crevices in the trap, and consists of grayish-green, or gray massive prehnite, resembling a granular quartzyte. Pebbles of this mineral are frequently picked up on the beach, all the way from two miles east of Lester river to French river, and often show small deposits of native copper. This fact rather indicates that it occurs more or less in the trap of the region, weathering out as the trap goes to pieces. At this place all the surface indications and the associated minerals are favorable for the existence of copper in large quantities in the rock of the region, which extends several miles along the shore.

There are a number of other unimportant openings for metallic copper. Some were made by John Mallmann near Duluth, and here is in heavy beds dipping n. 10° w., and has slicken-sided

*A full account of these operations may be seen in the collections of the Minnesota Historical Society for 1867, by Hon. H. M. Rice.

others near Beaver Bay, and Grand Marais. Of the latter, that of Johnson and Maguire is characteristic of the manner of occurrence of metallic copper in the trap of the region. This is situated on Fall river, and the working, done in the summer of 1876, is in the valley near the water, nw¼ Sec. 24, T. 61n. R. 1w. The greenstone seams, or thin fillings between the layers. These seams contain what appears to be prochorite, with stilbite and small quantities of calcite closely intermixed. Some of these seams are half an inch thick. The copper, however, does not occur in the seams or veins, but in the massive, hard greenstone, in thin spangling sheets, once or twice the thickness of paper, or even a quarter of an inch thick, which sometimes extend over two or three square inches, though in general they are smaller than that.

As an ore, copper has been sought by shafting near the centre of Sec. 16, T. 60, R. 2w., about three miles west of the mouth of Cascade river. Here is a series of veins, or a loose network, running in various directions, but in the main w. 19° n. This can be seen on the shore, and also under the water of the lake for some distance. Some veins are from one to two inches wide, and others nearly six, the aggregate being about four feet. This is embraced in a bedded trap, which is frequently veined, and parts with the "heulandite" coatings, so named by Norwood. It crumbles, on weathering, to a coarse gravel of a dirty green color. It has also hæmatitic red spots on the weathered surface. Lumps of ore, styled "gray copper ore," have been taken out of this location, indicating a vein from two to four inches wide, associated with much laumontite, and calcite and stilbite. The rock also contains what appears to be thomsonite. The shaft that has been sunk was filled with water when visited, and no examination below about ten feet, could be made. Similar veins carrying "gray copper," cross Pigeon Point peninsula, and appear on some of the islands south of the mainland. These are owned by James Caldwell and others, and but very little examination has been made, calculated to test their value.

SILVER.

The great argentiferous formation, or gray quartzyte (No. 4), enters the State from the British Possessions with a width, along the boundary line, extending from the Lake Superior shore to the west end of Gunflint lake. There have been a great many mining locations made in the area of this belt of rock, the greater number by far being for silver. The silver occurs in veins, or leads, generally of quartz with varying quantities of calcite, fluorite and barite.

In some of these veins is a curious gangue-rock of brecciated quartzyte firmly cemented by the minerals that accompany the vein; and in this case the veins are themselves largely made of this breccia, and differ less in outward characters from the quartzyte formation in which they occur. They are sometimes twenty or more feet in width. These veins, or leads, of mineral-bearing quartz occur when the formation has been fractured; and as the whole country consists of a succession of sharp mono-clinals in this rock, the veins are found to lie alongside of the broken off layers, following the faults that now are in the valleys. Hence they are frequently overlooked, being hid by the fallen debris or by the scanty foreign drift. Occasionally a fault is apparent in higher levels, and such veins have been first discovered and "claimed." In general they have an east-and-west course, except when some irregularity of direction accompanied the uplift. The silver of these veins is in the form of argentiferous galenite and as native silver, and some very rich deposits have been discovered.

In Minnesota, less mining has been done in this formation than in British territory, not because of less favorable indications, but because of the greater ease in making permanent claims and securing titles to land under Canadian laws than under those of the United States.

In the following account, some of the principal mining locations visited the past season are mentioned. There are a great many other veins, and also some other mining works, that the writer has not seen, because they are less accessible, or were unknown at the time the field-work was going on, and the plan for the time being did not admit of visiting them.

A wide vein of calcite and quartz, the latter being sometimes amethystine, occurs on the sw¼ Sec. 32, T. 64, R. 7 e. This location is now owned by Caldwell, Dunn, Lightbody, Farrel & Wakelin. The vein runs N. & S., and in 1874 was worked by A. A. Parker, who made several shallow openings, (6 to 10 feet) on it. It underlies toward the west superficially, and passes between joints in the quartzyte (which in spots is argillacious and slaty) having a width varying from one to five feet. It also embraces pieces of quartzyte. This vein is said to carry argentiferous galena, but very little could be seen in the pieces thrown out. The working, however, has not been adequate to properly test the character of the vein.

West of the foregoing about twenty rods, is another vein showing about a foot wide, thought to be a branch from the former. In this vein, on which no working has been done, croppings show heavy spar, calcite, carbonate of copper, and amethystine quartz, the bulk being heavy spar; runs N. 20° W.

About an equal distance east of the main (N. and S.) vein, is another vein, which shows about eight inches in width near the water level, but becomes indistinct, with included black quartzyte, and widens to two or three feet a rod or two from the coast. It sometimes appears wholly involved or lost in the formation, without calcite. This has not been worked, and is owned by the same parties. These three are thought to be parts of the same vein, and they probably are. Their direction is not in harmony with the direction of most of the veins examined further from Lake Superior, being rather transverse to the prevailing direction of the system of faults so conspicuous in the quartzyte, than coincident with it.

The last vein mentioned above seems to pass under the water southward, and to reappear on the south side of Susie Island, where several similar veins, five in number, can be seen, running in about the same direction. The most of these show no spar, but generally only a dark gangue-rock resembling a basaltic quartzyte, or a quartz breccia. That, however, which is supposed to be a continuation of another from the main land is three feet wide, and shows heavy spar near the water, and contains copper ore in the form of bornite and chalcopyrite, and also (argentiferous) galena.

About ¼ mile west of the last is a fine spar vein running in the direction of the island, nearly east and west, visible under the water near the shore eight inches wide and extending about 25 feet. It pinches out in both directions.

Baker and Kindred's location on Pigeon Point is about three-quarters of a mile east of the point that encloses Clark's bay, near the south shore of the peninsula. Here a shaft was sunk in the winter of 1877–8 by Mr. McPherson for the owners, but on striking water in about twenty feet, and being without facilities for pumping, the work was not then prosecuted further, and has not been resumed since. The shaft was sunk where two large veins cross each other, one of these veins *(a)* is 9 to 10 feet wide, runs east 15° south and the other *(b)* is 5 feet wide and runs south 10° east. Vein *(a)* is discontinued at the shaft, or continues a few feet as a closely jointed irony rock which was probably once charged with pyrites, and then is lost in the country rock; but a natural trench marks its course for several rods further west. It may reappear further on, but though the surface had been lately burned over, consuming even the vegetable mold of which the soil principally consists, no spar could be seen. The shaft principally discloses this vein, but is located a little too far east to show the contents of vein *(b)*. The minerals thrown out are calcite, barite and amethyst, with the ores pyrite, sphalerite, galenite and chalcopyrite.

These are visible. Others might be seen on having more favorable opportunities. No ore of any kind lies about the shaft, but small crystals and masses of these ores are scattered in the spar. There is also considerable pyrite and chalcopyrite connected with the lenticular masses, or "horses," of compact, hard, geenish rock that are enclosed in the spar. Vein *(b)* can be traced by the protruding spar (barite) a few rods beyond the shaft, but then is lost to sight. The spar of vein *(b)* is more firm than that of *(a)*, and more siliceous. It also embraces a different rock in irregular masses. There is a similar trench extending beyond the shaft in the direction of this vein, and even across the axis of the peninsula, though this is interrupted. Two similar heavy spar veins appear on the coast on the opposite side of the peninsula in Pigeon bay, which are without much doubt in the extension of these veins, though their direction is not exactly the same.

The tests that have been made of these heavy spar veins have been insufficient, and especially so by the fact that the shaft sunk by the owners did not open vein *(b)* at all.

The *White Rose* vein, known also as the Kindred vein, is about 1¼ miles north of the international boundary, at the east end of the first lake west of Mountain lake. On this have been sunk several shafts. Kindred's shaft is 37 feet deep, and the gangue minerals are calcite and quartz, the greater portion being calcite. These are mixed in irregular small veins and meshes through the quartzyte and slate of the country; the "vein" consisting of a brecciated and re-cemented fracture through the formation, and the cement being the minerals above, accompanied by galenite, native silver and pyrite. There is also in the calcite alongside of the blacker parts of the slate a copper-colored mineral in small hexagonal plates. It is brittle, and is said to fuse easily to a brittle globule. The best assay from this shaft is said to have got $1,100 per ton, but the ore has not been assayed by the survey.

Baker's shaft, which is on the same lead, about half a mile further west, is 26 feet deep. The vein here is conspicuously exposed on the face of a low bluff, facing SW. and is about 9 feet wide, with a "pay streak" increasing from six inches at the top to about 2½ft. at the bottom. The shaft goes partly in the slate, and then crosses the vein, which "hades" to the northeast. There is trap on the north side and slate on the south side, and trap rock is somewhat mixed with the vein also. The same minerals appear here as already named for the Kindred shaft. The best assay is said to have given $272 per ton; $16.60 per ton being got from poor quartz on

the north side of the vein, in which no ore could be seen with the naked eye.

The vein itself goes generally along the line of contact of slate (south side) with trap, but sometimes is wholly within the slate, and sometimes partly within the trap. The fracture, which seems to have been of the date of some subsequent igneous upheaval (as shown by the veined condition of the trap of the country), branched off, and also went somewhat zigzag in some places. It crosses Arrow lake, and can be seen on the other side as a conspicuous white belt on the bluffs, on that side crossing the slate and trap. In some places it is mostly of quartz, and there stands out above the surface.

On this vein are different parties located somewhat in the following order viz:

(a) West of the Kindred Brothers' location.

1. J. H. Baker, associated with Munger, Swan and others.
2. An eastern company.
3. Stewart, Sabin, Graves, Herman, Markell, Burg, Lightbody and Caldwell.
4. Geo. C. Stone & Co., Johnson, McKinley & McGuire.

Dr. Smith and —— Egan are also interested in some of these locations.

(b) East of the Kindred Brothers' location.

1. Hamilton, Sabin.
2. Dr. Stewart, McPherson,
3. Markell.
4. Col. Graves, Van Brunt.
5. Lightbody.
6. Caldwell.

William P. Spalding has a mining location on the south side of lake Miranda, which is a narrow long lake next north of lake Fanny, and on Sec. 5, T. 64, 2 E. This vein is strong, but not well defined. His work consists of several shallow pits for the purpose of ascertaining more definitely the position, direction and dip of the vein. What can be seen of it consists largely of breccia of trap, or of quartzyte recemented with quartz, in small, often drusy crystals. It is six or eight feet wide, and occurs, like others, along the north side of a quartzyte mono-clinal, and is largely hid by the talus materials. Mr. Spalding says he has taken out several pieces of native silver, but none was seen in the fragments thrown out.

On the other slope of this mono-clinal, south of the above, is another fracture, which seems likewise to have taken the nature of

a vein. Some working on this slope disclosed the existence of the fracture, and large float pieces of vein material indicate the contents, but the work had not gone far enough to precisely define its location and extent.

Mr. Spalding's "Ancient Diggings," so-called, consist of a series of depressions running along the supposed position of the first vein above mentioned, so as to make in some places a continuous trench. In some parts there are two ridges, with an irregular depression between them somewhat semi-lunar so that it unites again with the main depression. One of these ridges, that nearest lake Miranda, consists of clay and angular pieces of quartzyte; like talus *debris*, largely decomposed, but the other is of angular blocks, and Mr. Spalding says contains vein material, as if thrown out of the depression in excavating on the vein. These depressions show some openings within, between large boulders, and nearly large enough to admit a man, and after clearing out a little one was followed downward some feet. As yet no ancient hammers or implements of any kind have been found in the vicinity.

As to the cause of the depressions and parallel ridges, there may be three different explanations. Sufficient data are not at hand for affirming either.

First. They may be due to ancient mining, as supposed by the owner, though the non-discovery of hammers is necessary for the demonstration of this hypothesis. It is also true that the ancient mining hitherto discovered in the Lake Superior regions has been wholly for native copper, of which implements have been found in ancient works as far south as the state of Georgia, but so far as known, no silver implements have been found having so old a date; and the ancients seem to have had no knowledge of any process for reducing the ores, the silver in this formation occurring mainly as argentiferous galena.

Second—The depressions may be due to the solution and removal of the contents of a large vein under natural processes, and the consequent settling of the surface. When two depressions run nearly parallel in that case, the vein may branch out and become double, uniting again when the depressions unite. Then, also, the upper ridge, neared the bluff, would naturally contain coarser peices than that nearer the lake, which is true. Veins are thus dissolved sometimes, and sunken in for some distance, as the large baryta vein on Pigeon Point. This cause, if true, indicates a strong vein, and one that, with the quartz now remaining as the sole matter undissolved, must be charged with soluble minerals, and perhaps with very valuable ores. Deep shafting alone will deter-

mine it. So far as exposed, however, the quartz remaining now undissolved is sufficient to form a firm frame-work, capable of supporting the overlying materials so as to prevent such a collapse of the surface as here supposed.

Third—These ridges may be of the nature of ice ridges or moraines. There are a great many instances of ridges thrown up by the ice of lakes through alternate freezing and thawing both in Minnesota and Iowa, and sometimes such have received the name of "walled lakes." But aside from this, the ice of the last ice period may have lain for a long time prior to its final disappearing, in the rocky valleys of the northern part of the State, as suggested by Mr. John Lightbody. Its effect, along a rocky bluff, would be to form low, blind ridges of debris or morainic material. which would remain more or less distinct to the present under favorable conditions. In that case the coarser nature of the ridge nearer the bluff would be due to the fallen pieces from the bluff itself, while the clay of the ridge nearer the lake may have been due to drainage in that direction and to the crushing action of the ice in times of expansion. The level of the ice would remain nearly constant under the same causes which now keep the level of the water nearly constant.

These considerations are here mentioned, as there seems to be a tendency at other places in the northern part of the State to attribute such phenomena to ancient mining, perhaps without sufficient reason.

John McFarland's location is on Secs. 9 and 10 T. 64 N. R. 3 E. He has two veins, and one place thought to be a site of ancient mining, in all respects similar to that of Mr. Spalding, except that this series of ridges and depressions is not near any lake at present, but alongside a bluff enclosed in a valley. If a vein should be discovered at this locality, then Mr. McFarland has three distinct veins situated on different sides of a mono-chinal hill, viz.: one on the north side, one on the south side and one on the east side, the last being that in which are the supposed ancient diggings. These are all close together, and the east and west veins are all well marked, running also across the adjoining valleys and appearing in the next hills. They are outwardly of quartz and brecciated quartzyte, and occupy faults between the slate and the trap of the country. Mr. McFarland has done no work on his veins, but is occupied in farming and fur-catching.

Johnson's working is on a vein situated, as nearly as could be ascertained, on SE ¼, Sec. 32, T. 65, 3 E. This is also on the south slope of a hill, but has trap on the north side and slate on the

south side, being really in a fault like the rest; but the slate is here brought up like the south vein at Spalding's, on a line nearly parallel with the upper surface of the trap. This vein shows mainly calcite, but has also quartz pyrite, galenite, and native silver. These can be seen in the dump near the shaft. There is also, as in nearly all the other veins seen, a large amount of brecciated quartzyte and siliceous slate. This is here mainly on the south side of the vein, while the north side is in a similar manner filled with breccia of trap. This appears to be a strong vein, and one that promises well.

McFarland, Rice and Ramsey have a very conspicuous and strong vein near the shore of Pine Lake, on S. E. quarter sec. 31, T. 65 N., R. 1 E. This has not been worked, but slightly uncovered in two places. It has an irregular direction, width and appearance, large white masses of calcite and quartz lying about promiscuously, apparently in place, over a width of several rods north and south. Where it has been uncovered it is also mixed with a breccia of quartzyte, and has a width of ten or twelve feet. It seems to have trap on the north side, but it is not well exposed. A trap bluff rises abruptly toward the northwest, facing east and south, and the vein is in a lower level, having a zigzag course, governed, apparently, in direction and deflected by that upheaved trap and slate along its western extent, so far as it is visible; but further east it has a more uniform course in consonance with the general trend of the hills, yet this, like Spalding's second and one of McFarland's, is on the southward slope of the main hillside. The calcite and quartz, not mentioning the breccia, are the most abundant gangue-rock. The ores are pyrites (said to be auriferous) galenite, sphalerite and chalcopyrite. These, with the exception of the galenite, can be made out in examining the pieces in the dump. This seems to be as strong and promising a vein as the White Rose, near Arrow Lake.

IRON.

The gray quartzyte and slate, which is particularly known as the silver-bearing formation, and contains the foregoing silver veins and mining works, graduates below into a siliceous iron-charged rock, which in some places furnishes a valuable iron ore in large quantities. The silica is often colored so as to make jasper, flint, chalcedony, and other parti-colored pebbles when the formation disintegrates. These gave name to Gunflint Lake, on the international boundary, the beach of which is strewn with them. There are also "dolomitic" bands, and these sometimes contain angular pieces of jasper and flint, associated with the same beds in some

manner not yet made out. What may be the thickness of this bed of iron ore rocks has not been ascertained. They seem to be conformable both with the overlying quartzyte, and with the underlying schists and slates, but this may not generally be the case. There are various places at which this belt of iron ore is known, but the most important is that known as the "Mesabi Iron Range," situated in towns 59 and 60 N. of range 14 W. The range itself probably extends a great many miles, maintaining its ferriferous character, and covers other known locations. Some working has been done also back of Grand Marais, and some near Vermillion Lake.

The iron in towns 59 and 60, range 14, has attracted the most attention, probably because of a costly exploration made there a few years since by parties from Pottsville, Penn. The ownership of the locations that were examined becoming involved in litigation nothing practical has resulted publicly from the examinations. The information obtained belongs to private parties. Samples of this ore are being examined chemically by the survey. According to published analyses the ore varies in metallic iron from 61 to 66 per cent., being mainly in the form of magnetic oxide. Its chief impurity is silica, from 5 to 10 per cent. It has from 2 to 3 per cent. of lime, and from a half of 1 per cent. to 1½ per cent. of magnesia. Manganese oxide varies from about one-half of 1 per cent. to 1.3 per cent. No sulphur has been detected in it, and but a trace (less than one-fourth of 1 per cent.) of phosphoric acid. Alumina varies from one-fourth of 1 per cent. to over one-half of 1 per cent.

The following is an analysis by Prof. Campbell, of the School of Mines, of New York:

Magnetic oxide of iron	86.862
Oxide of manganese	1.313
Silica	9.980
Lime	2.046
Magnesia	1.299
Alumina	.633
Total	102.133

The following was made by Prof. E. R. Taylor, of the Cleveland Laboratory of Analytical Chemistry, Cleveland, O.:

Insoluble siliceous matter	4.06
Iron as metal	65.62
Iron protoxide	23.34
Sulphuric acid	None.
Phosphoric acid	.18
Lime	3.15
Magnesia	.50
Manganese oxide	.64
Alumina	.35
Total	97.84

The ore resembles those of Scandinavia and Russia, as well as the magnetic ores of northern Michigan, and the geological age is the same, in general terms. For making steel these ores excel, and iron from the Scandinavian furnaces is imported into England for the manufacture of steel. It is highly probable that these iron deposits will not lie long undeveloped. They are in the midst of hardwood timber sufficient for producing the necessary charcoal, and the surrounding country is generally fit for prosperous farming. They are easily accessible by the construction of roads either from Thomson, Duluth or Beaver Bay. From Thomson the distance is about 65 miles, from Duluth due north about 55 miles, and from Beaver Bay about 45 miles.

GOLD.

The region of Vermilion Lake has been known for some years as a gold-bearing region. This was fully brought out by the reports of H. H. Eames in 1866. At that time a flush of feverish excitement led to the expenditure of considerable money in sinking shafts and erecting works for mining. Three steam stamp mills were erected, another running by water power. One was owned by the New York Mining Company, whose location was near the "Mission" on the south shore, another by Nobles & Company, further northwest, and another by Seymour & Company. The water power mill was owned by the Wabasha Company, and was located about two miles from Vermilion Lake, at Trout Lake. Eight or ten mining companies were at work simultaneously in different parts, mainly on the southern shores, or on islands. A town site was laid out at the southern extremity of the Lake, several large buildings put up, and stated communication made with Duluth. The village was named Winston. Above the village, at Pickerel Falls, a lum-

ber mill was projected, and the foundations laid. These things have all passed away. There is not a building at Winston. Two of the steam boilers were hauled back to Duluth, where they are still in use; the mills have been burnt, as well as most of the buildings put up by the mining companies. the shafts, generally filled with water, are abandoned, and there is but a single white man (a government officer) to be found in the whole district.

The gold occurs with pyrites, some of which appears to be cupriferous. This pyrites is found in milky white quartz which accompanies the joints of the rock, and also is disseminated through the rock itself. The most of the working was done on quartz deposits, but that of Nobles & Company embraced also a large amount of the rock itself. The rock of the region is of the Huronian age, and follows immediately below the ferriferous formation last described. It is mainly a talcose slate, but varies to an argillaceous talcose slate and to a talcose quartzyte. It also passes into what may be styled provisionally a syenite. The schistose structure runs a little north of west, and stands almost perpendicular. Samples of this quartz ore yielded on an average about twenty-five dollars per ton, according to assays reported by Mr. Eames. Samples of the ores of this region have been collected by the survey, as well as of all other mining locations mentioned, and in time thep will receive analysis and further report.

THE NEEDS OF THE NORTH SHORE.

First—During the season all parties connected with the survey have had occasion to note the frequent and wanton destruction of the native forests by fire which rages annually and destructively. There is nothing so utterly ruined and desolate as a country lately burnt over. The soil itself, consisting very largely of vegetable mold, is burnt to considerable depth, or quite to the rock. Thousands of acres of the finest forest timber, including large pine trees, are thus destroyed every year. It is estimated that annually ten times as much pine is thus destroyed in the State as is cut by all the mills. A large part of the triangle north of Lake Superior has thus been devastated. Some sheltered tracts have escaped. The State has lost in this way more than as much pine as now remains, and will at no very distant day awake to the fact of having lost by neglect, and willful or careless destruction, one of her chief resources. These fires are set generally by travelers or explorers. The Indians remonstrate, and are generally careful about their camp-fires in the dry season, well knowing the effect fire has the game that furnishes their chief sustenance.

The scattered white inhabitants are too few to effect anything in stopping these fires, except in the preservation of their immediate surroundings, and they also complain that the country is thus being rapidly desolated. It rests with the State Legislature to take some action to punish those who wantonly or carelessly set the forests on fire, similar to that to punish those who fire the prairies. If concerted action were taken by the State and the Canadian authorities it would be more effectual, since fires originate on both sides of the boundary line.

Second—There should be some improved harbor on the north shore for refuge for vessels in time of storms, although there may not be commerce to demand it at any one locality. At the present time there is no lighted harbor for vessels between Duluth and Thunder Bay in Canadian Territory, and between these points there is a great deal of travel. The establishment of a single good harbor would at once attract travel, trade and settlement, and would tend to the development of some of the mineral interests that now lie dormant largely because so inaccessible.

Third—There is a wrong opinion prevalent regarding the agricultural character of the northeastern part of the State. It is pronounced by some who have not seen it, as mountainous, sterile and untillable. These terms apply to but a small portion of it, viz.: a belt from one to four miles wide along the shore of Lake Superior, and a tract of unknown area in the extreme northeastern corner, and along the boundary line westward to Vermilion Lake and the west end of Hunter's Island. In these parts the rock of the country is perhaps the most conspicuous feature. But south of the Mesabi range, and particularly in the St. Louis valley, the country is generally flat, the streams are slow and broad, the soil a loam or a sandy loam, or a stony clay, and equal in all respects, except in being farther north, to thousands of acres that have been cleared and converted into valuable farms in the states of Michigan and Wisconsin. When it is remembered that more than a hundred miles further north, in Canada, railroads, canals and settlement are rapidly being introduced, and that still further north and west, beyond the ameliorating action of the water of Lake Superior, is thought to be one of the great wheat fields of the Continent, it is plain that there is nothing to prevent the final occupancy and development of northeastern Minnesota as an agricultural district.

III.

FIELD REPORT OF C. W. HALL.

Prof. N. H. Winchell, State Geologist:

SIR—In accordance with the plan arranged by you for the prosecution of the State Geological Survey during the past autumn, the Lake Superior section of the geological corps reached Grand Marais August 30. The work of this section was to be the exploration, so far as practicable, of the rivers emptying into Lake Superior, from the lake shore to their headwaters; and the ascent of some of the more prominent peaks of that continuons chain of low mountains skirting the northeast shore. The chief object of this work was to trace out the rock formations, so far as the river beds and the bluffs would show them, and to articulate the same upon those already traced along the coast of the lake during the summer months; or to indicate the direction of the latter as they extend onward into the interior of the State.

As a canoe and provisions for the expeditions to be made from Grand Marais along the lake shore and into the interior had to be procured, and an Indian hired to serve as a packer and guide, one or two days time was consumed in preparation. And then, after all was ready, the condition of the lake prevented our starting. While waiting for heavy northwest winds to subside the hill back of Grand Marais was ascended, its hight measured and search made for out-crops of rock that would give some clue to the lithological character of the elevation. In measuring the height accurate results were not expected, since one series of observations made with an Aneroid barometer, and extending through a whole day can be no more than an approximation to accuracy. The height of the hill as determined was 775 feet. Two or three interesting exposures of igneous rocks were found, evidently as broad dikes or overflows, and some water from a "caribou lick" on the south side of the hill, was collected.

After a rainy and rough passage we reached Indian River the seventh of September. An examination of this stream, which forms a part of the boundary between the Grand Portage Indian Reservation and the unsurveyed lands lying in the northwestern part of the State, was to be our first work. The river is so rapid throughout its entire length that there is no canoeing until the lakes in which it has its source are reached, and there is not even a fisherman's trail along its banks. Fortunately in the upper part of its course the stream flows through a more level country, intersected by numerous caribou trails; otherwise

it would have been almost impossible for the packers to have made their way. When there were no trails to follow not more than three or four miles could be made in a day. In this heavily wooded country of the Lake Superior region the dense undergrowth and the windfalls are much greater obstructions along the river courses than away from them. When on the height of land to the east of the the river, we struck the sugar bush of the Grand Portage Indians, and followed their trail along the ridge to Grand Portage. At this place an Indian was hired to take the party to their late camp in his canoe.

A thick stratum of drift overlies nearly the whole region drained by the Indian river. Along its course are many banks of that red drift clay so frequently met with in the northeastern part of the State.

The next expedition was up the small stream called by Dr. Norwood in Owens' report, Flute Reed river. Being nearly out of provisions one of the men, a half-breed Indian named Antoine, was sent to Grand Marais for fresh supplies, while the remaining two made a two days' trip up the river. The progress made here was quite satisfactory since the timber for nearly the whole distance traveled had been burned only two seasons before. Antoine was taken sick at Grand Marais and was unable to return. As Mr. Mayhew sent another in his stead but little loss ot time was occasioned thereby.

A creek emptying into the lake in the S. E. ¼ Sec. 2, T. 61, R. 2, E. 4th Mer. shows some very beautiful features. The gorge which the water has worn through the jointed shaly rock is one of the grandest of the many grand works of nature between Duluth and Pigeon Point. Its depth often exceeds one hundred feet and the walls are occasionally so near—in two or three places from four to eight feet—that fallen trees form foot bridges from one side of the stream to the other. Several domes seventy-five or eighty feet high are worn in the walls. The bottom of the gorge is dark and gloomy for the sunlight never enters except here and there in straggling rays. Toward the headwaters of this stream and overlooking a beautiful lake is the sugar bush of Timote Sunamo. At a distance it looked as if outcrops of rock could be found there. A day was spent in making an excursion to the place. The summit ot the hill by the old sugar camp was 1,240 feet above Lake Superior. No rock was found except drift boulders and these occurred to the very summit.

Kimball's creek came next in order for examination. Owing to the character of the rock—it was identical with that found along the stream last visited—and the shortness and smallness of the stream, only one day was devoted to the work.

Thus having made a hasty examination of nearly all the streams from Pigeon Point to the Brule river we started for Grand Marais that we might there make preparations for the ascent and examination of that stream. This would necessitate an expedition of at least four week's duration into the interior. But a severe storm, which made the trip to Grand Marais in our canoe a somewhat dangerous one, continued with drenching rains for more than a week. When the weather was again fair, not only had much valuable time passed by, but the river was rushing down to the lake in a torrent and the swamps were full and almost impassable. Accordingly it was thought best to abandon the idea of ascending the Brule the present season, and, instead, examine some of the smaller, shorter streams and a country freer from swamps. Rosebush river, a small stream in whose bed, one and one-half miles from the lake shore, is an abandoned copper mine* receceived a second visit, the first having been made in

*This mine lies in the N. E. ¼ of N. W. ¼, Sec. 24, T. 61, R. 1 W.

the summer by the State Geologist and his party accompanied by Professor Peckham and Mr. H. Mayhew.

Good Harbor Bay also received a call. This is one of the most interesting localities for the student of geology that the whole Northwest shore affords. Around the point to the west of the bay occur the beautiful thomsonites thickly studding the upper strata of a bed of apparently igneous rock; while along the shore of the bay a bed one hundred or more feet in thickness of nearly horizontal sandstone lies sandwiched in between the thomsonite-bearing rock just mentioned and another igneous rock underneath. Many minerals occur in the several beds for the most part in a concretionary form. The distance of this locality from Grand Marvis is only five or six miles.

The last expedition made from Grand Marais during the season was for an examination of the shore line some miles to the eastward of that place and the ascent of the Devil's Track River to the head of Devil's Lake. As a preliminary step our canvas canoe and a supply of provisions were packed into the interior to a point on the river about two miles below the foot of the lake. We started from Grand Marais on the eighteenth of October. Although the results attained along the coast were all that could be desired the expedition as a whole was not entirely satisfactory. The water in the river was so high that the ascent could be made only by following along the summit of the bluffs. On Devil's Lake our canvas canoe was used for the first time. It was found harder to row and at the same time not so swift as a birch bark canoe. But the fact that it is light and can be folded and packed through almost any part of the forest renders it peculiarly adapted to our work. The canoe we had was hastily made and delivered to us in a very unsatisfactory condition, and much time and labor were required to make it in the least serviceable; still that is no argument against a light, strong and *well made* canoe. Having finished our work on the morning of Friday, the twenty-fifth day of October, in the midst of a blinding snow storm, we struck camp and started for Grand Marais. We had gone scarcely more than two miles before we were met by a messenger sent by Mr. Mayhew announcing the glad news that on the following day the schooner *Beaver Bay Charley* would touch at Grand Marais on her way from Grand Portage to the head of the lake. This word hastened our steps; we reached the lake, placed everything in readiness, but the vessel never came; only the dreary prospect lay before us of a voyage in an open boat over the more than one hundred miles stretching between us and Duluth. The task was undertaken and ended after five days exposure to cold and danger—for it was the week of disasters on the lakes—by our being taken up at Beaver Bay by the tug Nellie Cotton and brought to Duluth, which place we reached November 2d.

In giving this account of the work done, it cannot be out of place to mention the obligations of the party to the Mayhew brothers and Mr. Howenstein, of Grand Marais, for favors shown on every occasion. Messrs. Mayhew placed a building at our disposal, in which to lodge whenever we were in the place, and all spared no pains, and suffered no opportunity to pass by, for rendering assistance, particularly in giving knowledge of the country which was the field of our explorations.

Although a whole season has now been given to the examination of the Lake Superior region, as yet the work is hardly begun. I would suggest that all the time possible from the limited amount at the disposal of the survey, be given to this part of the State. Facts may be here gleaned that will have great weight in the determination of certain scientific questions of universal interest. My con-

viction becomes stronger, as the survey progresses, that the geological structure of this part of the State is more simple than has generally been supposed. Many theories have been pronounced without sufficient foundation of fact, and their multiplicity serves only to confuse him who would through reading arrive at a a clear understanding of the lithological and historical characters of the Lake Superior rocks.

Respectfully submitted,

C. W. HALL.

IV.

ELEVATIONS ON THE MINNESOTA NORTHERN RAILROAD.

By J. B. CLOUGH, Chief Engineer.

NAME OF PLACE.	Township.	Range.	Section.	Miles from Wadena.	Elevation above the sea.
					Feet.
Wadena	134	35	6	0	1349
Prairie southwest of Wadena	134	36	15	4	1370
Bluff Creek (surface)	134	36	15	4½	1355
Bluff Creek (grade)	134	36	15	4½	1365
Bluff Creek, west branch (surface)	134	36	15	5	1361
Bluff Creek, west branch (grade)	134	36	15	5	1365
General surface at head of Bluff Creek	134	36	30	8	1408
Marsh, head of Deer Creek	134	37	35	10	1391
General surface, south line of Deer Creek twp.	134	37	34	11	1417
Tamarack Swamp, head of Rock Creek	133	37	4	12	1405
Tamarack Swamp, Big Spring	133	37	7	13½	1412
Height of ridge ¾ mile south of Tam'k Swamp, spur of Leaf Mt	133	37	18	14½	1632
Height of divide in marsh	133	37	17	15	1439
Leaf River bottom	133	38	14	16½	1407
Leaf River grade	133	38	14	16½	1417
General surface of Pease Prairie	133	38	27 & 33	18 to 20	1456
Crossing East Butte Creek	132	39	1	22½	1367
Crossing East Butte Creek grade	132	39	1	22½	1377
Summit grade (spur of Leaf Mountain)	132	39	11	24	1388
Tops of Leaf Mountains in vicinity, estimates	132	39	11	24	1475
South Butte Creek bottom	132	39	10	25½	1320
South Butte Creek grade	132	39	10	25½	1325
East Butte Lake, estimates	132	39	10	25½	1318
Summit in gap	132	39	5	27	1357
General surface estimate	132	39	5	27	1450
Lake Clitherall, at Clitherall	132	40	11	30	1332
West Butte Creek bottom	132	40	11	30½	1329
West Butte Creek grade	132	40	11	30½	1333
Summit, spur of Leaf Mountain	132	40	3	32	1376
Valley	132	40	4	33	1346
Summit, spur of Leaf Mountain	133	40	32	34½	1366
Turtle Lake surface	133	40	31	36½	1322
Turtle Lake grade	133	40	31	36½	1332
Summit between Turtle and Bass lakes	133	41	32	41	1340
Bass Lake surface	133	41	31	42	1324
Bass Lake grade	133	41	31	42	1344
Summit grade	133	42	36	45	1354
Red River bottom	133	42	33	47½	1224
Red River grade	133	42	33	47½	1239
Summit	133	42	30	49	1292
Surface of Red River at Fergus Falls	133	43	35	52	1172
Grade at Fergus Falls	133	43	35	52	1182

Line of the Pelican River Valley.

NAME OF PLACE.	Township.	Range.	Section.	Distance from Fergus Falls.	Elevation above the sea.
Summit	133	43	10	4	1261
Height of land ½ mile east summit	133	43	10	4	1320
First crossing Pelican River	134	43	29	9	1222
Second crossing Pelican River	134	43	20	10	1226
Third crossing Pelican River	134	43	20	10¼	1233
Fourth crossing Pelican River	135	43	4	20	1277
Pelican River below dam at Pelican Rapids	136	43	27	22	1292
Pelican River above dam at Pelican Rapids	136	43	27	22	1302

V.

CHEMISTRY.

REPORT OF PROF. PECKHAM.

Prof. N. H. Winchell:

MY DEAR SIR:—In conformity with the instructions of the executive committee* of the Board of Regents, I have the honor to report regarding my trip to Lake Superior as follows:

*See Appendix A.

I was instructed to advertise the intended action of the Board in sending me there in Duluth and St. Paul. This advertising was done, and from all that I could learn all persons likely to be insterested were well informed in regard to the matter.

I was also instructed that "any parties who will make affidavit that they are citizens of Minnesota, and that the ores are found in Minnesota, giving the localities where the ores were found as nearly as possible, and certifying their willingness that the results may be published, shall be charged one-half the * * prices."

"Payment for assays may be made in specimens of minerals or ores, at Prof. Peckham's valuation."

These instructions were also well advertised on the north shore, but no assays were offered subject to these conditions. No ores or minerals were therefore received in part compensation for assay work.

When not employed in assaying, I made collections of minerals in the neighborhood and on the coast above and below Grand Marais. Some of these specimens are large, in fact too large for exchange, and were gathered with the expectation that you might want them for the General Museum.

I also obtained by private purchase a quantity of zeolite pebbles, that on examination present some features of interest. I have thought that possibly you might desire a chemical examination for the survey, and I have therefore delayed a thorough examination until I could lay the matter before you.

These specimens are of considerable value, and I found that the only way in which I could secure a suite for our cabinet and prevent them from going out of the State, was to purchase the whole lot.

The specimens to which I have referred above as having been collected with a view to being placed in the General Museum have been opened, and are now awaiting your inspection at the Agricultural Building. I trust that you will make it convenient to look them over soon, as they are getting dusty.

An early decision in reference to the examination of the minerals purchased, will oblige,

Very truly yours,

S. F. PECKHAM.

MINNEAPOLIS, Nov. 11th, 1878.

The following results have been obtained for serial numbers 55, 56 and 57. They were all three limestones. They were dissolved in dilute hydrochloric acid and boiled. The portion remaining insoluble was estimated as "insoluble." The iron, etc., lime, magnesium, carbonic and sulphuric acids, were then estimated in the usual manner. The results were as follows:

	55	56	57
Insoluble	24.21	16.22	2.82
Ferric and aluminic oxides, $F_2O_3 + Al_2O_3$	3.32	1.14	1.39
Calcium Sulphate, $CaSO_4$	4.32	.73	6.74
Calcium Carbonate, $CaCO_3$	47.11	54.28	52.22
Magnesium Carbonate, $MgCO_3$	20.76	27.48	36.04
	99.72	99.85	99.21

The very small percentage of alkalies amounting to but little more than a trace, was not determined.

No. 55 contained druzy cavities filled with pure white granular silica, which would cause the insoluble portion to vary in different pieces.

The insoluble portion of No. 56 contained a large amount of iron in an insoluble form. No. 57 is a very pure magnesian limestone.

These three specimens are the only ones that I have received in time to complete their analysis.

S. F. PECKHAM.

MINNEAPOLIS, Jan. 30th, 1879.

VI.

ORINTHOLOGY.

REPORT OF DR. P. L. HATCH.

MINNEAPOLIS, January 23, 1879.

Prof. N. H. Winchell:

DEAR SIR—It is my pleasure to be able to report a satisfactory progress of the Ornithological section of the Natural History Survey of the State during the year just closed.

The distribution of resident species of birds, the lines of those migrations which most affect such distribution, and the interest of agriculture, have occupied the attention of the survey largely. Personal visitations of remote localities in the best times for observation and the restricted employment of local amateurs, have greatly facilitated the accumulation of reliable data.

Questions of profound interest to science have multiplied, which can only be settled by a thorough exploration of all sections of the State not yet settled for agricultural purposes, which it is hoped the present year's opportunities may afford new facts for their solution. The characteristics of the different sections are so varied that each must receive special observation almost simultaneously, which compels me to depend much upon the principal lines of rapid transit. The "passes" on the Minneapolis, White Bear and Duluth railroads added very much to my facilities during the past year. I think that if similar advantages could be afforded over the other lines of railroads penetrating remote sections hitherto unexplored by the Survey, results of surpassing interest may be attained during the present year. My co-laborer and invaluable assistant, Mr. C. E. Herrick, has not enjoyed his usual opportunities for aiding me during the last year which I had hoped, on account of his time being absorbed in another department of still greater importance to science. I shall permit myself to hope that he may be able to render greater service during the year just begun.

I am very respectfully yours,

P. L. HATCH.

VII.

BOTANY.

THE PLANTS OF THE NORTH SHORE OF LAKE SUPERIOR. BY B. JUNI.

The greater part of the forest of the north shore consists of evergreens, such as spruce, pine and cedar. Birch is nearly everywhere interspersed, and poplars are nearly as common. From French River northward the trees gradually decrease in size. Already at Grand Marais the difference is quite apparent. At Pigeon Point the trees seem to be but half grown. The same is true of altitude; on the ridge of Mount Josephine there is only a stunted growth of trees, which at its foot reach the ordinary size. This can hardly be due alone to the difference of moisture and soil. The abundance of mosses and lichens gives to the forest a character peculiar to northern latitudes. There is scarcely a rock or tree that is not partly or entirely covered by the different species. The ground is often covered by a layer nearly a foot in thickness, which conceals the angular fragments of rock beneath. In many places there is no soil except what is entangled in the mosses and lichens. This fact serves to make fires all the more destructive. They consume everything, to the very rock; nothing remains but the charred trunks of trees, many of which fall at the time, while others, whose roots struck into some deep crevice of the rock, stand a few years longer as monuments of the destructive folly of man. The next rain or wind carries away the last traces of soil, and leaves the rocks bare and calcined. Nature now sets about to cover again the surface by an other slow succession of lichens, shrubs and trees. The trees in proximity to the lake, and especially on the side facing it, are draped with a moss-like lichen (Usnea longissima?). This hangs in long tufts of about a foot and a half from trunk and branches. When dry it is as combustible as shavings or straw. It is by no means an unimportant article in this region. For packing specimens and for bedding, there is no better material. This lichen is found both upon live and dead trees, but more commonly upon some species than upon others. There are some wrong theories prevalent regarding it. It neither injures a live tree nor has it any preference between a live and a dead one, as long as the bark to which it attaches itself remains upon the tree. Its nourishment is derived from the air and not from the tree upon which it lives.

Myriads of caterpillars have stripped the younger growth of deciduous trees of their foliage in a number of places this season.

Swarms of grasshoppers appear to have passed over these regions, but thousands happened to alight in the lake instead of on the land. In Grand Portage Bay great numbers of them were seen floating on the water still alive and eager to take passage on any floating object.

The resinous matter of the wood which falls into the streams, is said to impart to the water that dark amber color peculiar to all streams which enter upon the north shore.

About fifteen hundred specimens of plants have been collected and preserved, which represent, perhaps, one hundred and seventy-five species. More than that number have been identified, but it was not found convenient to preserve all specimens. The duplicates are intended for exchange. A full collection of Carices, to which special attention was given, was lost.

In considering the results it should be borne in mind that no expenses to the State have been incurred, which would not have been necessary without them. A few leisure hours were given to this work by one who did full duty in another line.

List of Plants of the North Shore of Lake Superior.

RANUNCULACEÆ.*

r Clematis Virginiana, *L.* Virgin's Bower.

Thalictrum Cornuti, *L.* Meadow Rue.

Ranunculus Cymbalaria, Seaside Crowfoot. Found only at Grand Portage.

Ranunculus Pennsylvanicus, *L.* Bristly Crowfoot.

c Caltha palustris, *L.* Marsh Marigold.

Aquilegia Canadensis, *L.* Wild Columbine. Very beautiful, flowering late in August.

Actaea spicata, *Var.* rubra, *Michx.* Red Baneberry.

NYMPHACEÆ.

Nuphar advena, *Smith.* Yellow Water Lily.

SARRACENIACEÆ.

Sarracenia purpurea, *L.* Pitcher-plant. Abundant in open marshes.

FUMARIACEÆ.

r Corydalis aurea, *Willd.*

r Corydalis glauca, *Pursh.* Burnt ridges.

**r* Signifies that the species is rare.
c Signifies that the species is common, and
vc Very common.

CRUCIFERÆ.

c Cardamine hirsuta, *L.* Bitter-cress.
Arabis perfoliata, *Lam.* Tower Mustard. Poplar River.
Arabis Drummondii, *Gray.* Castle Danger.
Barbarea vulgaris, *Michx.* Putin Bay. Common Winter Cress or Yellow Rocket.
Draba arabisans, *Michx.* Castle Danger.

DROSERACEÆ.

Drosera rotundifolia, *L.* Sundrew. *c.*
Drosera longifolia, *L.* Little Marais.

CARYOPHYLLACEÆ.

Stellaria media, *Smith.* Common Chickweed. Grand Portage.
Stellaria longipes, *Goldie.* Duluth.
Cerastiurm nutans, *Rap.* Mouse-ear Chickweed.

GERANIACEÆ.

Geranium Carolinianum. *L.* *c.*

BALSAMINACEÆ.

Impatiens fulva, *Nutt.*. Spotted Touch-me-not.

ANACARDIACEÆ.

Rhus toxicodendron, *L.* Poison Ivy.

SAPINDACEÆ.

Acer spicatum, *Lam.* Mountain Maple. Very abundant everywhere; grows usually in clumps, generally a mere bush.

Acer saccharinum, *Wang.* Owing to the scarcitv of other hard wood this is highly valued for hard fuel and charcoal. Considerable quantities of sugar are made from it, both by Indians and whites. This tree is not once met with on the immediate lake shore; it can be found only some distance inland. In addition to the above mentioned maples Acer Pennsylvanicum and Acer rubrum are occasionally found, it is said.

LEGUMINOSÆ.

Vicia Americana. *Muhl.* Vetch. *c.*
Lathyrus maritimus. *Bigelow.* Beach Pea.
Grows in patches in coarse sand or gravel, where no other plants thrive. Resembles very much the common field pea. Along the whole length of the shore within the limits of Minnesota, it was observed in only three places, viz: French River, Two Island River and Poplar River.
Lathyrus ochroleucus. *Hook.* *c.*

ROSACEÆ.

Prunus Pennsylvanicus. *L.* Wild Red Cherry.

Prunus Virginiana. *L.* Choke Cherry. *v. r.*

Spiræa opulifolia. *L.* Nine-Bark. Here, unlike further south, it shuns the soil, but clings to bare rocks, often within the sweep of the waves.

Spiræa salicifolia. *L.* Common Meadow Sweet.

Agrimonia Eupatoria. *L.* Common Agrimony.

Geum album. *Gmelin.* Makes a good substitute for tea; was sometimes used as such on the survey of the north shore.

Geum strictum. *Ait.* *c.*

Potentilla Norvegica. *L.* Five-Finger.

Potentilla fruticosa. *L.* Shrubby Five-Finger.

Common on bare, rocky shores north of Two Island River, becoming more abundant further north.

Potentilla tridentata, *Ait.* More common and less confined to rocks than the last.

Fragraia Virginiana, *Ehrhart.* *c.* Strawberry.

Fragraria vesca, *L. c.* Very prolific.

Rubus Nutkanus, *Mocino.* White Flowering Raspberry. Occurs everywhere on dry soil. Its showy white blossoms are about as large as those of the wild rose. The fruit is large and looks tempting but has a peculiar acid flavor which makes it inferior to that of the R. strigosus.

Rubus trifl‸rus, *Richardson.* Dwarf Raspberry.

Rubus strigosus, *Michx.* Wild Red Raspherry. *c.* Especially abundant and prolific on burnt places a few years after fires. Both the quantiy and the quality of the fruit is extraordinary.

Rosa lucida, *Ehrhart.* Dwarf Wild Rose (?).

Amelanchier Canadensis, *Torr. & Gray.* Pigeon Point.

Pyrus Americana, *D. C.* American Mountain Ash. *c.*

The large cymes of white blossoms in summer as well as the crimson fruit in autumn and winter give a pleasant relief to the dark background of evergreen. The tree was in full bloom at Duluth on the 20th of June, while on Pigeon River some were found in flowers nearly two months later.

Cicuta maculata. *L.* Spotted Cowbane.

Cicuta bulbifera. *L.*

Sium Carsonii. *Dnrand*, ined. Temperance River.

ARALIACEÆ.

Aralia hispida. *Michx.* *c.* Bristly Sarsaparilla.

Aralia nudicaulis. *L* Wild Sarsaparilla. *c.*

CORNACEÆ.

Cornus Canadensis. *L.* Dwarf Cornel.

Cornus circinata. *L'Her.* Round-leaved C.

Cornus stolonifera. *Michx.* *c.* Gray attaches the name "Kinnikinnik" to C. sericea. This only serves to mislead beginners, and gives rise to disputes, as the name "Kinnikinnik" applies with equal propriety to C. stolonifera, and to

Arctostaphylus uva ursi. The Indians use the inner bark of the two former and the dried leaves of the latter as tobacco; hence the same name.

Cornus alternifolia. *L. r.* Poplar River.

CAPRIFOLIACEÆ.

Linnæa borealis. *Gronov.* So abundant that it often forms a beautiful setting in the moss carpets in the woods. It was in blossom at Duluth on the 20th of June, and on the 27th of September it was still found blooming at Grand Marais. (See Foster and Whitney.)

SAXIFRAGACEÆ.

Ribes Cynosbati, *L.* Comomn Wild Gooseberry.

Ribes lacustre, *Poir.* Agate Bay.

Ribes prostratum, *L'Her.* Fetid Currant. Known in this region by the name of "Skunk Berry." More prolific than the Ribes rubrum and the berries larger, but hardly eatable on account of the unpleasant odor.

Ribes floridum, *L.* Red Currant. Little Marais. Plant and fruit like the red garden currant. Without the fruit the plant is not easily distinguished from the R. prostratum.

Parnassia palustris, *L.* Grand Portage Island.

Saxifraga Pennsylvania, *L. c.*

ONAGRACEÆ.

Circæa apina, *L.* Enchanter's Nightshade, *c.* This plant contains many raphides.

Epilobium angustifolium, *L.* Great Willow Herb. Very common, especially on burnt land.

Epilobium coloratum, *Muhl. c.*

Epilobium palustre.

Œnothera biennis, *L.* Common Evening Primrose.

UNBELIFERÆ.

Hydrocotyle umbellata, *L.* Water Pennywert.

Sanicula Marilandica, *L.* Sanicle.

Heracleum lanatum, *Michx. v. c.*

Lonicera hirsuta, *Eaton.* Hairy Honey Suckle, *c.*

Lonicera ciliata, *Muhl.* Fly Honey Suckle.

Diervilla trifida, *Mœnch, v. c.* Bush Honey Suckle. Forms a large part of the underbrush.

Sambucus pubens. *Michx.* Red-berried Elder.

Viburnum Opulus. *L.* Bush Cranberry. *c.*

Much stunted and fewer berries in each cyme, which nearly leads one to take it for V. pauciflorum.

RUBIACEÆ.

Galium asprellum. *Michx.* Rough Bed-Straw.

Galium triflorum. *Michx.* Sweet-scented Bed-Straw.

Houstonia purpurea. *L. Var.* longifolia. Gooseberry River.

COMPOSITÆ.

Eupatorium purpureum. *L.* Joe Pye Weed. *c.*
Aster cordifolius. *L.* Little Marais.
Aster sagittifolius. *Willd.* Agate Bay.
Aster pumiceus. *L.* Grand Portage Island.
Aster gramminfolius. *Pursh.* *c.*
Aster ptarmicoides. *Torr and Gray.*
Solidago bicolor. *L.* Golden Rod. *c.*
Solidago Muhlenbergii. *Torr and Gray.*
Solidago Canadensis. *L.*
Heliopsis lævis. *Pers.* Ox-Eye. *c.*
Anthemis nobilis. *L.* Beaver Bay.
Senecio tomentosus, *Michx.* Put in Bay.
Achillæa Millefolium, *L.* Common Yarow. Abundant all along the shore, forming a fringe of white just on the line between the forest trees and the waves. Was not found in other situations. A few specimens with light purple flowers were seen.
Gnaphalium decurrens, *Ives.* Everlasting. Deronda Bay and Grand Portage Island.
Senecio aureus, *L.* Golden Ragwort.
Arnica mollis, *Hook.*
Cirsium lanceolatum, *Scop.* Common Thistle.
Hieracium Canadense, *Michx.* Hawk Weed. *c.*
Nabalus albus, *Hook.* White Lettuce.
Mulgedium floridianum, *D. C.* False Blue Lettuce.

LOBELIACEÆ.

Lobelia Kalmii, *L.* Abundant on bare trap shores north of Agate Bay.

CAMPANULACÆ.

Campanula rotundifolia, *L.* Harebell. *c.*
Campanula rotundifolia, *L.* *Var.* linifolia. Pigeon Point.
Campanula aparinoidei, *Pursh.* *c.* Marsh Bell Flower.

ERICACEÆ.

Gaylussacia resinosa, *Torr. & Grry.* *c.* Black Huckleberry.
Vaccinium Oxycoccus, *L.* Small Cranberry.
Vaccinium uliginosum, *L.* Bog Billberry.
Chiogenes hispidula, *Torr. & Gray.* Pigeon Point.
Arctostaphylus uva ursi, Spring Bearberry.
Ground thickly covered by it in open places; Indians use the dried leaves to mix with their tobacco for smoking and call it "Kinnikinnik."
Gaultheria procumbens, *L.* Wintergreen. Palisades.
Epigæa repens, *L.* Trailing Arbutus. Minnesota Point.
c Ledum latifolium, *Ait.*
c Pyrola rotundifolia, *L.*

c Pyrola elliptica, Shin-leaf.
Pyrola chlorantha, *Swartz*. French River.
Pyrola secunda, *L*. *Var*. pumila.
c Moneses uniflora, (*L*. Pyrola uniflora.)
Monotropa uniflora, *L*. Indian Pipe. Grand Marais.

PLANTAGINACEÆ.

Plantago major, *L*. Common Plantain.

PRIMULACIÆ.

Primula Mistassinica, *Michx*. Trap shores.
c Trientalis Americana, *Pursh*. Star Flower.
Lysimachia stricta, *Ait*. Split Rock River.
Lysimachia ciliata, *L*. Split Rock River.

LENTIBULACEÆ.

Utricularia, minor *L*. Smaller Bladderwort. Duluth.

SCROPHULARIACEÆ.

c Chelone glabra, *L*. Turtle-head.
Mimulus ringens, *L*. Monkey Flower.
Gratiola pilosa, *Michx*. Agate Bay.
Veronica arvensis, L. Corn Speedwell. Duluth.
Melampyrum Americanum, *Michx*. Cow-wheat. *c*.

LABIATÆ.

Mentha arvensis, *L*. Corn Mint. Baptism River.
Lycopus Virginicus, *L*. Bugle-weed. Knife River.
Lycopus Europæus, *L*. *Var*. integrifolius and *var*. sinuatus. Baptism River.
Brunella vulgaris, *L*. Common Self-heal. Duluth.
Galeopsis Tetrahit, *L*. Common Hemp-nettle. *c*. At some places the color of the flower is a yellowish white, while at others it is purple.
Phlomis tuberosa, *L*. Jerusalem Sage. Knife River.

BORRAGINACEÆ.

Mertensia paniculata, *L*. Lungwort. Abundant and showy.
Echinospermum Lappula. *Lehm*. Stickseed. Duluth.

GENTIANACEÆ.

Halenia deflexa, *Griesbach*, Supurred Gentian.
Menyanthes trifoliata, *L*. Buckbean. *c*.

POLYGONACEÆ.

Polygonum cilinode, *Michx*. *c*.
Rumex Acetosella, *L*. Sorrel. *c*.

ELÆAGNACEÆ.

Shepherdia Canadensis, *Muhl.* Dry shores.

SANTALACEÆ.

Comandra livida, *Richardson.* Bastard Toad Flax.

URTICACEÆ.

Urtica gracilis, *Ait.* Nettle. Agate Bay.

CUPULIFERÆ.

Corylus Americana. *Walt.* Knife River.

Corylus rostrata. *Ait.* Everywhere and (contrary to Foster and Whitney) fertile. In some places the bushes reach a height of fifteen feet, with stems from one to one and a half inches in diameter. The tops bend over from the weight of the fruit.

Ostrya Virginica. *Willd.* Hop-Hornbeam. Reported as growing on the ridges in the interior.

BETULACEÆ.

Betula lutea. *Michx.* Yellow Birch. Inland.

Betula papyracea. *Ait.* Paper or Canoe Birch.

This tree is valuable not so much for its wood as for the great variety of uses to which the bark can be turned. In many instances the tree reaches a height of seventy feet.

Betula glandulosa. *Michx.* Dwarf Birch. Swamps.

Betula rotundifolia. *Spach.* Swamps.

Alnus viridis. *D. C.* Green Alder. Bare rocks and dry banks.

Alnus incana. *Willd.* Swamps and wet banks.

SALICEÆ.

Populus tremuloides. *Michx.* American Aspen. *v. c.*

Populus grandidenta. *Michx.* Unusually large.

Populus balsamifera. *Var.* candidans. *L.* Balm of Gilead. *c.*

CONIFERÆ.

Pinus Banksiana, *Lambert.* Scrub Pine. *c.*

Pinus resinosa, *Ait.* Red Pine. *c.*

Pinus Strobus, *L.* White Pine. This is rather scarce along the shore, but is abundant a few miles inland. It sometimes forms a forest, but is more frequently seen single or in clumps of a dozen or two interspersed among the other trees. The decaying trunks lying in the shade of a young growth show that the tree is by no means stunted in this latitude. At Knife River a fallen tree was measured and found to be 125 ft. in length and 3½ to 4 ft. in diameter.

Abies nigra, *Poir.* Black Spruce.

Albies alba, *Michx*. White Spruce. *c*.

Albies balsamea, *Marshall*. Balsam Fir. *c*. The Canada Balsam is obtained from the blisters in the bark of this tree.

Larix Americana, *Michx*. Tamarack. *c*. It is here found both in swamps and on dry land.

Thuja occidentalis, *L*. Arbor Vitæ. *c*. Though the trunk is frequently two feet in diameter, it tapers so rapidly that it is of little value as timber. The trees either standing or fallen make an almost impassable barrier to the explorer.

Juniperus communis. *L*. *Var*. alpina. *c*.

Toxus baccata. *L*. *Var*. Canadensis. American Yew.

ARACEÆ.

Calla palustris. *L*. Bogs, Duluth.

Acorus Calamus. *L*. Sweet Flag. Knife River, Duiuth.

TYPHACEÆ.

Sparganium simplex. Hudson Bay Reed. Agate Bay.

NAIADACEÆ.

Potamogeton crispus. *L*. Pond Weed. Agate Bay.

ORCHIDACEÆ.

Habenaria obtusa. *Richardson*. *c*.

Habenaria orbiculata. *Torr*. *c*.

Habenaria psycodes, *Gray*. *c*.

Goodyera pubescens. *R. Br*. *c*.

Spiranthes Romanzoviana. *Chamisso*.

IRIDACEÆ.

Iris versicolor. *L*. Blue Flag.

Sisyrinchium Bermudiana. *L*. Blue Eyed Grass.

LILIACEÆ.

Streptopus amplexifolius. *D. C*. Twisted Stalk.

Clintonia borealis. *Raf*. *v*. *c*.

Smilacina trifolia. *Ker*. Putin Bay.

Lilium Philadelphicum. *L*. Trap shores.

JUNCACEÆ.

Juncus alpinus, *var*. insignis. *Fries*.

Juncus Canadensis. *J. Gray*. *Var*. co-arctatus.

CYPERACEÆ.

Eriphorum alpinum. *L.* Cotton Grass.
Carex polytrichoides. *Muhl.* Little Marais.
" stipata. *Muhl.* Moose Lake.
" trisperma. *Dew.* Putin Bay.
" canescens; *var.* vitilis. *L.* Agate Bay.
" Deweyana. *Schw.* Agate Bay.
" lagopodioides. *Schk.* Agate Bay.
" stricta. *Lam.* Agate Bay.
" lenticularis. *Michx.* Agate Bay.
" crinita. *Lam.* Putin Bay.
" gynandra. *Schw.* Agate Bay.
" irrigua. *Smith.* Putin Bay.
" alpina. *Schwartz.* Temperance River.
" livida. *Willd.* Greenwood River.
" arctata. *Boott.* Agate Bay.
" flexilis. *Rudge* Knife River.
" filiformis. *L.* Putin Bay.
" lanuginosa. *Michx.* Common everywhere.
" riparia. *Curtis.* *c.*
" paludosa. *Good.* *c.*
" retrorsa. *Schw.* Moose Lake. *c.*
" intumescens. *Rudge.* *c.*
" monile. *Tuckerman.* Agate Bay.
" oligosperma. *Michx.* Baptism River.

GRAMINEÆ.

Zizania aquatica. *L.* Indian Rice. Water Rice.
Calamagrostis Canadensis. *Beauv.* Blue Joint.
Poa caesia. *Smith.* Meadow grass.

FILICES. (Ferns.)

Polypodium vulgare. *L.* (?)
Pteris aquilina. *L.* Common Brake.
Adiantum pedatum. *L.* Maidenhair.
Onoclea sensibilis. *L.* Sensitive Fern. *c.*
A number of other species of ferns were collected but not identified.

LYCOPODIACEÆ. (Club Moss.)

Lycopodium inundatum. *L.* *r.* Pallisades.
Lycopodium annotinum. *L.* *c.*
Lycopodium dendroideum. *Michx.* Ground Pine.
Lycopodium clavatum. *L.* *c.*
Lycopodium complanatum. *L.* *c.*

The following is a list of plants that either constitute the greater part of vegetation on the comparatively bare belt of a few rods width in immediate contact with the water, or grow there exclusively. The margin of the forest is in gen-

eral a well defined line, reaching, where the conformation of the coast admits, as far down as the highest waves are thrown. The strip between this line and the level of the lake is exposed to winds and waves, and destitute of soil, except what filters into cracks of the rocks, or is retained in some ancient pot-hole.

Campanula rotundifolia. *L.* Harebell. *Var.* linifolia. Both common, and exclusively on this belt.

Potentilla tridentata. *Ait.* Becomes less common northward. Is most abundant at Duluth. Grows occasionally inland.

Potentilla fructicosa. Makes its first appearance at Knife River; grows more common thence northward. Only on rocks, and more rare inland.

Aster gramminifolius. Knife River, and northward. Its roots are firmly set into the cracks.

Solidago bicolor. Takes the higher and more favorable positions.

Primula Mistassinica. Wet cavities or pot-holes, usually with Juncus and Drosera. Common on flat trap.

Drosera longifolia. Same as preceding.

Juncus alpinus. Same as preceding.

Draba arabisans. On high rocks.

Barbara vulgaris. Sheltered and stony beach near water level at Putin Bay.

Arabis Drummondii. High walls at Castle Danger.

Achillea Millefolium. Forms a white fringe along the timber line. The most retired, but always in its place.

Rhamnus alnifolius. *L'Her.* Buckthorn.

Spiræa opulifolia. Very common. About the only shrub on many rocky shores; clings to the lowest and most exposed ones, also on high walls.

Thuja occidentalis. Not so common as inland, but maintains its hold upon life in the most unfavorable positions. Often the only representative of the vegetable kingdom on a lone rock in the lake, where its stem and branches plainly indicate the direction of the prevailing winds and waves.

Alnus viridis. Less thrifty than inland.

Lilium Philadelphicum. Occasionally on trap.

Lathyrus maritimus. Gravelly or sandy beaches.

In addition to the above, there are three species of Gramineæ which have not been identified. These are often found on the most exposed places.

Additional Species identified at the University, by B. Juni.

Phacelia bipinnatifida. *Michx.* Near campus.

Draba Caroliniana. *Walt.* Abundant on campus.

Alyssum calycinum. *L.* Around Agricultural College.

Erodium cicutarium. *L'Her.* Agricultural College.

Camelina sativa. *Crantz.* Agricultural College. Only two specimens found. May not appear again.

Aster multiflorus. *Ait.* Campus.

Lychnis vespertina. *Sibth.*. Near campus. Not viscid.

Oxybaphus nyctagineous. Sweet. Campus.

Acerates lanuginosa. *Decaisne.* Near campus.

Veronica perigrina. *L.* Near campus.

Lycium vulgare. *Dunal.* Sidewalks, E. D.; rare.

Linaria vulgaris. *Mill.* Common on University Avenue.

Arabis hirsuta. *Scop.* Common on the bluffs.
Prunus pumila. *L.* Rare; bluffs.
Cardamine hirsuta. *L.* Brook.
Eleocharis palustris. *R. Br.* Brook.
Scirpus validus. *Vahl.* Brook.
Lathyrus palustris. *L.* Near the brook.
Troximon cuspidatum. *Pursh.* Ft. Snelling to Chaska.
Veronica Virginica. *L.* White Bear.
Veronica Americana. *Schweinitz.* Brook.
Veronica scutellata. *L.* Brook.
Asclepias ovalifolia. *Decaisne.* White Bear.
Baptisia tinctoria. *R. Br.* White Bear
Scrophularia nodosa. *L.* Campus.
Verbena hastata. *Michx.* Campus.
" urticifolia. *L.* Campus.
" stricta. *Vent.* Campus.
" bracteosa. *Michx.* Campus.
Spiræa opulifolia. *L.* Bluffs.
Solidago odora. *Ait.* Brook.
Stipa spartea. *Trin.* Campus.
Amphicarpum. *Purshii, Krunth.* Campus.

CAREX.

Backii. *Boott.*
teretiuscula *Good.*
disticha. *Huds.*
vulpinoidea. *Michx.*
conjunta. *Boott.*
rosea. *Schk.*
tenella. *Schk.*
scoparia. *Schk.*
tenuiflora. *Wahl.*
stellulata. *L.*
vulgaris. *Fries.*
aquatilis. *Wahl.*
aurea. *Nutt.*
granularis. *Muhl.*
Torreyi. *Tuckerman.*
flaccosperma. *Dew.*
gracillima. *Schw.*
digitalis. *Willd.*
Pennsylvanica. *Lam.*
Richardsonii. *R. Br.*
pubescens. *Muhl.*
miliacea. *Muhl.*
lanuginosa. *Michx.*
hystricina. *Willd.*
longirostris. *Torr.*

The sedges enumerated above have been found in the vicinity of the University. Taking into account those found on the north shore, there have been in all forty-six sedges identified the past summer, fully three-fourths of which have not heretofore been identified; at least they were not published. This number by no means represents all the species of Carex in this State. The sedges are commonly not distinguished from the grasses proper. They form a large part of the food for cattle and wild ruminants, especially in woody districts.

VIII.

REPORT ON THE GENERAL MUSEUM.

CONTAINING THE COLLECTIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY FOR 1878.

By N. H. Winchell, Curator.

The work in the museum has been carried on mainly in the laboratory of the Geological Survey. In the earlier part of the summer Mr. Herrick prepared a number of thin sections of rock for the microscope, collected by the survey in different parts of the State. The excellent lathe of Mr. A. A. Julien, purchased for this purpose, with the accompanying apparatus, has proved eminently useful, and will become still more so as the laboratory work of the survey progresses. Later in the summer plants and birds were added to the museum by Mr. Herrick and Mr. Juni, and the botanical collection now assumes considerable proportions. At the same time many memoranda of unexpected localities, and variations or peculiarity in species, have been preserved for use when systematic work on these collections shall be attempted. A few plants from Iowa have been obtained of Mr. Roberts.

Further collections have been made of fossils from the Trenton limestone, and also from the so-called "Northwestern limestone" of the drift in the vicinity of Minneapolis. Mr. Herrick's ornithological notes are reported to Dr. Hatch.

On the return of parties from the field-work of the survey, a systematic examination and registration of the material gathered during the past six years, not previously examined and reported, was begun in the laboratory, and has been in progress up to the present time. These comprised about two hundred boxes and miscellaneous packages of specimens, some of which will require

minute examination and study. This is true particularly of the crystalline rocks of the northern part of the State. For the purpose of this work, and owing to the large increase of the number of boxes the present year, another room in the basement of the University was occupied by order of the Executive Committee, and was fitted with suitable shelving and tables for storage and convenient handling. The accompanying catalogue shows how far the registration has proceeded, and the general character of the specimens so far as examined.

At the same time the work of mounting the *Megatherium*, mentioned in the last report, which had been temporarily re-stored in an empty case of the north room, was begun, and as much time given to it as the various other duties of the Curator would permit. It will require some weeks further time, but it will not be long now before it will be completely set up, and will constitute one of the chief attractions of the Museum.

Mr. W. H. Chambers, a student in the University, has presented a fine specimen of Rock Sturgeon (Acipenser rubicundus. Le. S.) taken by him in the Mississippi, near the University. which has been mounted by Mr. Wm. Howling, of Minneapolis, and is on exhibition in the Zoological apartment of the Museum.

From time to time specimens of minerals are presented to the Museum. These will be found acknowledged in the following catalogue. A circular relating to duplicates in the Museum, and to exchanges for the same, was issued in December, for distribution to parties desiring exchange.

CATALOGUE OF SPECIMENS REGISTERED

In the General Museum in 1878.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
219	Oct, 1872.	Geol. Survey	Limestone	2	Winona, Minn	St. Law'ce	N. H. Winchell
247	May, 1873	A. M. Hutchinson.	Galena	1	Spring Valley, Minn	Galena	Presented by A. M. Hutchinson
854	1872.	A. D. Roe	Tetrahedrite (Gray copper)	1	Simsbury, Ct.		Presented by A. D. Roe
855	"	"	Scapolite	1	Gouverneur, N. Y		" "
856	"	"	Amphibole (bladed tremolite) in Dolomite	1	Canaan, Ct.		" "
857	"	"	Talc and Dolomite (Bittu Spar)	1	Middlefield, Mass		" "
858	"	"	Mica and Chlorite	1	"		" "
859	"	"	Molybdenite	1	Westmoreland, N. H		" "
860	"	"	Iron (Octahedral)	1	Franklin, N. J		" "
861	"	"	Amphibole (Tremolite)	5	Canaan, Ct		" "
862	"	"	Amphibole (Black Tremolite)	1	"		" "
863	"	"	Siderite (Spathic Iron)	1	Roxbury, Vt		" "
864	"	"	Fluorite (Fluate of Lime) Var. Chlorophane	1	Trumbull, Ct		" "
865	"	"	Pectolite (on Trap)	1	Bergen, N. J		" "
866	"	"	Calcite	1	"		" "
867	"	"	Limonite (Stalactitic)	1	Salisbury, Ct.		" "
868	"	"	Magnetite (in massive Garnet)	1	Chester, Vt		" "
869	"	"	"Lithomarge"	3	Chester, Mass		" "
870	"	"	Chromite and Serpentine	1	"		" "
871	"	"	Vein of Prehnite (in Gneiss)	2	Bellows Falls, Vt		" "
872	"	"	Amphibole (Fibrous Tremolite)	1	Canaan, Ct		" "
873	"	"	Calcite (Iceland Spar)	1	Gouverneur, N. Y		" "
874	"	"	Amphibole (Radiating fibrous Tremolite)	1	Canaan, Ct		" "
875	"	"	Limonite	2	Salisbury, Ct		" "
876	"	"	Amphibole (Asbustos)	1	Chester, Mass		" "

Catalogue of the Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
877	1872.	A. D. Roe	Margarodite and Massive Topaz	2	Trumbull, Vt.		Presented by A. D. Roe
878	"	"	Limonite (stalactitic, coated with ochre).	1	Salisbury, Ct.		" "
879	"	"	Serpentine (Picrolite)	1	Chester, Mass.		" "
880	"	"	Beryl (yellow)	1	Ackworth, N. H.		" "
881	"	"	Andalusite (in Mica slate)	1	Charleston, N. H.		" "
882	"	"	Amphibole (Hornblend, white)	1	Paulings, N. Y.		" "
883	"	"	Talc	1	Middlefield, Mass		" "
884	"	"	Garnet (cinnamon) and Zoisite (in Hornblend rock	1	Chester, Mass.		" "
885	"	"	Iolite (Chlorophyllite)	1	Unity, N. H.		" "
886	"	"	Fossiliferous Marble	1	Glen's Falls, N. Y.		" " [schist.
887	"	"	Garnet (trapezohedral)	10	Reading, Ct.		" " In mica
888	"	"	Pyroxene (Augite, white).	1	Not known		" "
889	"	"	"Lead (Sulph.) in granyte"	1	Southampton, Mass		" "
890	"	"	"Recent Conglemorate"	1	Bermuda		" "
891	"	"	Fluorite (vein in granyte)	1	Westmoreland, N. H.		" "
892	"	"	Quartz (Chrysoprase)	1	New Fane, Vt.		" "
893	"	"	Cyanite	1	Litchfield, Ct.		" " [227.
894	"	"	Graphic Granite	1	Paris, Maine		" " Orig. No
895	"	"	Menaccanite (Titanic Iron)	1	Chester, Mass.		" "
896	"	"	Cyanite	1	Huntington, Mass		" "
897	"	"	Prehnite and Calcite (on Gneiss)	1	Bellows Falls, Vt.		" "
898	"	"	Serpentine	1	Cavendish, Vt.		" "
899	"	"	"Varigated Marble"	1			" "
900	"	"	"Manganese"	2	Salisbury, Ct		" "
2118	"	"	Apatite	1	Gouverneur, N. Y.		" "
2119	"	"	Limonite (coated with ochre)	4	Salisbury, Ct.		" "

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2121	1872.	Geol. Sur.	Chalcopyrite	1	Bruce Mines, Canada	Huronian	Presented by A. D. Roe
2123	1873.	"	"Amygdaloid"	1	Maine Prairie	"	Presented by Prof. Ira Moore.
2125	"	"	Limonite		Little Falls	Drift	Prof. Ira Moore (from adyke).
2126	"	"	Fossil Wood	1	Yellowstone Park	"	Presented by N. Herrick
2127	"	"	Sandstone	1	Falls of Prairie River	Potsdam	Presented by Prof. Ira Moore.
2128	"	"	Granyte	1	St. Cloud		"
2129	"	"	Granyte	1	St. Cloud		N. H. Winchell
2131	"	"	Granyte (White)	2	Watal		"
2132	"	"	Granyte	2	Sauk Rapids		"
2133	"	"	Granyte	2	Sauk Rapids		"
2134	"	"	Impure Kaolin	10	Redwood Falls		"
2135	"	"	Cretaceous Lignite	Indf	"		"
2137	"	"	Cretaceous Lignite	1	"		"
2138	"	"	Red Granyte	1	Lac qui Parle		"
2139	"	"	Red Granyte	3	Montevideo		"
2140	"	"	Red Granyte	2	Foot of Bigstone Lake		"
2141	"	"	Coarse Red Granyte	3	T. 120, R. 44, Minn. river		"
2142	"	"	Cretaceous Brecia	1	Upper Minn. river, D. T.		"
2143	"	"	Cretaceous Sandstone	10	8 miles below New Ulm.		" (Fritz quarry,
2144	"	"	Red Granyte	2	Lac qui Parle....[4th M.		" [lft b'k Minn. R)
2145	"	"	Quartzyte	1	Prairie riv. Falls, t.56, r.25		Presented by N. Butler
2146	"	"	Iron Ore	1	Prairie riv. Falls, t.56, r.25		" "
2147	"	"	Quartz containing iron	1	Minn. Falls......[4th M.		N. H. Winchell
2148	"	"	Gneiss	1	Redwood Falls		" (Building rock)
2149	"	"	Feldspar and Mica	2	2 m. bel. Vicksb'g, Minn		"
2150	"	"	Calcareous Tufa	2	Coteau de Prairie, D. T.		" (Herrick's)
2151	"	"	St. Lawrence Limestone	3	Judson		"

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of specimens.	Locality.	Formation	Collector and Remarks.
2152	1873.	Geol. Sur.	St. Lawrence Limestone	1	Judson		N. H. Winchell
2153	"	"	Calciferous Sandstone	1	Near Judson, (S. E.)		"
2154	"	"	Concretious from Cretaceous Sandstone	Indf	New Ulm		" So-called fruits
2155	"	"	Conglomerate	3	"		"
2156	"	"	Lignite	1	"	Drift	" Dauffenbach's.
2157	"	"	Cretaceous Marl	1	"	Cretaceous	" Winkelmann's Quarry.
2158	"	"	" "	1	"	"	" Dauffenbach's [Quarry.
2159	"	"	Cretaceous Clay	Indf	Mankato	"	"
2160	"	"	Calcite (Nail-head Spar)	1	New Ulm	"	" Winkelmann's
2161	"	"	Cretaceous Limestone	8	" [Ulm.	"	" "
2162	"	"	Clay	Indf	Cottonwood R. (S. W. N.	"	" Potter's clay
2163	"	"	Clay	1	Near New Ulm	"	" Dauffenbach's
2164	"	"	Shakopee Limestone	4	Near Mankato	Shakopee.	" Clapp's Quarry
2165	"	"	Shakopee Limestone	4	Shakopee	"	"
2166	"	"	St. Lawrence (?) Limestone	2	Jessenland		"
2167	"	"	Shakopee Limestone	2	Louisville	Shakopee.	"
2168	"	"	Jordan Sandstone	3	Van Ozer's Creek	Jordan	"
2169	"	"	Limestone	3	St. Lawrence	St. Law	"
2170	"	"	Aluminous Marl	1	Near Kasota	Cret.	"
2171	"	"	Ferruginous Sandstone (Laminated)	1	Maple River	"	"
2172	"	"	"St. Peter Sandstone"(?)	4	St. Peter		"
2173	"	"	Red Granyte	2	3½ ms. below Ft. Bidgley		"
2174	"	"	Gnessoid Quartzyte	2	Granite Falls		"
2175	"	"	Hornblendic Schist	1	"		" [rock.
2176	"	"	Shale	Indf	Spirit Is'd, Minneapolis		" Under the lime-
2177	"	"	Granyte (Red)	1	Watab		"

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2178	1873.	Geol. Sur.	Impure Kaolin	6	Brich Coolie		N. H. Winchell.....[pottery.)
2179	"	"	Clay	1	Cottonwood River	Cret	" (wo'ld not m'ke
2180	"	"	Lignite	Indf	Crow Creek, near Redwood Falls		"
2181	"	"	Ferruginons Shale (Silurian surface) from Sub-Cretaceous	2	Mankato		"
2182	"	"	Concretionary (Impure) Kaolin	4	Post's Creek,(Minn.riv.)		"
2183	"	"	Contretionary (Impure) Kaolin	3	" "		"
2184	"	"	Shakopee Limestone	2	Kasota		"
2185	"	"	Ripper-marked Sandstone	1	New Ulm		"
2186	"	"	Inoceramus, &c	Indf	Near Sioux City, Iowa	Cret	"
2194	"	"	Peat	2	Lura	Drift	W. Z. Haight
2195	1874.	"	Greenisb Limestone	1	Twin Lakes, Freeb'n co	Drift	N. H. Winchell (from boulder).
2196	"	"	Limestone	4	Northw'd, Worth co., Ia	Dev	"
2197	"	"	Stromatopora	7	3 ms. S. of Northw'd, Ia	Dev	"
2198	A'g. 5,'74.	"	Rose Quartz	2	Near Custer's Park, Black Hills		"
2199	" 8,'74.	"	Quartzyte	5	Near Custer's Park. Black Hills		"
2200	J'y 23,'74.	"	Phonolyte	2	Horse Shoe Ridge, Heeng-ya-ka-ga P'k, (Inyan Kara) D. T.		"
2201	"	"	Pnonolitic Trap	3	Sum't Heeng-ga-ka-ga		"
2202	J'y 26,'74.	"	Sandrock	3	Castle Valley, B. Hills		"
2203	J'y 24,'74.	"	Limestone	2	Near Heeng-ya-ka-ga, Black Hills		"
2204	J'y 25,'74.	"	Limestone	1	Minnelusa Valley, Black Hills		"

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2205	J'y 31, '74	Geol. Sur.	Felsite	3	Harney's Peak, Blk. Hills		N. H. Winchell
2206	" 29, '74	"	Garnetiferous Mica Schist	6	Park Country, Blk. Hills		"
2207	A'g 12, '74	"	Chlorite Slate	1	Eastern part of Blk. Hills		"
2208	J'y 23, '74	"	Limestone	3	Heeng-ya-ka-ga, Black Hills		"
2209	A'g 17, '74	"	Fossil Wood	3	"Slave Butte," near Black Hills		"
2210	J'y 29, '74	"	Mica Schist with various minerals	5	Park Country, Blk. Hills		"
2211	J'y 26, '74	"	Limestone	6	Castle Valley, Blk. Hills		" The great limestone formation of the Black Hills.
2212	1874.	"	Peat	1	Freeborn County	Drift	N. H. Winchell
2213	J'y 21, '74	"	Gypsum	7	Redwater Valley, Black Hills	Jurass	"
2214	J'y 31, '74	"	Granyte (with Tourmaline Crystals)	3	Top of Harney's Peak, Black Hills		"
2215	J'y 30, '74	"	Granyte (with Tourmaline)	8	Custer Park, Black Hills		"
2216	J'y 25, '74	"	Sandstone, Pinkish	4	Minne-lusa Valley Black Hills		" Under "Carb. Limestone."
2217	J'y 21, '74	"	Red Sandstone	2	Redwater Valley, Black Hills		"
2218	A'g 8, '74	"	Limestone	10	Near Custer's Park, Black Hills		"

Catalogue of Specimens Registered in the General Museum in 1878—Contined.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2219	J'ly 14, '74	Geol. Sur.	Siderite	2	Castle Butte, near Black Hills	Cret.	N. H. Winchell
2220	J'ly 17, '74	"	Barite	3	Short Pine Buttes, near Black Hills	Cret.	"
2221	A'g. 5, '74	"	Muscovite	2	Near Harney's Pe'k Black Hills		"
2222	A'g. 17, '74	"	Barite	Indf	Slave Butte, near Black Hills	Cret.	"
2223	A'g. 17, '74	"	Selenite	9	Slave Butte, near Black Hills	Cret.	"
2224		"	Sandy Concretions	9	Black Hills, Dak	Cret.	"
2225	J'ly 21, '74	"	Belemnites densus. M. and H.	Indf	Near Belle Fourche river, Dak	Cret.	"
2226	J'ly 11, '74	"	Lignite	Indf	"Ludlow's Cave," Dak.	Cret.	"
2227	1874.	A. J. Tubbs	Cannel Coal	1	Pennsylvania		Presented by A. F. Tubbs
2228	"	W. W. Folwell	Clay (red)	1	Afton, Minn	Drift	Presented by W. W. Folwell
2229	"	Geol. Sur.	Marl	1	Near Austin	Cret.	N. H. Winchell, (Gregson's mill)
2230	"	"	Clay (white)	1	Near Austin	Cret.	"
2231	"	"	Clay (blue)	Indf	Near Austin	Cret.	"
2232	"	"	Clay (yellow and red)	Indf	Near Austin	Cret.	"
2233	"	"	Coarse Granyte (with Tourmaline)	Indf	Near Custer Park, Black Hills		"
2234	A'g. 2, '74	"	Tourmaline (Black)	Indf	3 miles S. of Custer Park, Black Hills.		"
2235	"	"	Talcose Slate	2	Black Hills, Dak		"
2236	"	"	Slate	2	Black Hills, Dak		"
2237	"	W. H. Bassett	Hæmatite	2	T. 56, R. 15, Minn		Presented by W. H. Bassett
2238	"	Geol. Sur.	Limestone	1	Le Roy		N. H. Winchell

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained.		NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
	When.	Where.					
2239	1874.	Geol. Sur.	Stromatopora	1	LeRoy	Dev.	N. H. Winchell
2240	"	"	Favosites	2	3 ms. S. of Northwood, Iowa	"	"
2242	"	"	Mica Schist	1	Black Hills, Dak.		"
2243	A'g 10, '74	"	Iron Ore	1	Eastern part of Blk. Hills		"
2244	A'g 1, '74	"	Mica Schist (with Crystals)	2	2 ms. S. W. of Harney's Peak		"
2245	1874.	"	Sand	1	Minneapolis	St. Peter	" (W. drift St. Anthony Falls tunnel.
2246	"	"	Sand	1	"	"	N. H. Winchell, (E. drift St. Anthony Falls tunnel.
2247	"	"	Shale	Indf	"	Trenton	N. H. Winchell, (St. Anthony Falls tunnel.
2248	"	Mr. Cole	Lignite	Indf	Near Albert Lea	Drift	Presented hy Mr. Cole
2249	"	Geol. Sur.	Quartz Sand (blackened by Iron)	Indf	Near Austin		N. H. Winchell, (Gregson's mill)
2250	"	"	Sand Concretions	Indf	"	Cret.	" "
2251	1872.	S. D. Haskin	Fossil Wood	1	Near Kasota	Drift	Presented by S. D. Haskin
2252	"	Geol. Sur.	Sand	Indf	Winona	St. Croix	N. H. Winchell
2253	?		Red Ochre	1			
2254	1872.		Argentiferous Galena	1	Bear Butte, Dak. Ter.		From the Eldofusia Mine
2255	"	Geol. Sur.	Magnesia Sulphate (mostly)	1	Mantorville		N. H. Winchell, (Weathers from face of the bluff at Willson's Quarry.)
2256	"	"	Fine Red Clay	Indf	Stillwater	Drift	N. H. Winchell, so-called Tripoli.
2257	"	"	"Lacustrine Clay"	4	Rochester	"	N. H. Winchell

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2258	1872.	A. M. Hutchinson.	Colored Clays	2	Near Spring Valley	Cret	Presented by A. M. Hutchinson
2259	"	Geol. Sur	Fossiliferous Slabs	Indf	Taylor's Falls	Potsdam	N. H. Winchell
2260	1873.	"	Iowa Coal	1	Iowa	Carbonif.	"
2261	"	W. W. Folwell	Tully Limestone	1	Waterloo, N. Y.	Dev.	Presented by W. W. Folwell
2262	"	"	Clay Slate	1	Genesse Co., N. Y.	Mos. shale	" "
2263	"	Geol. Sur	Fossiliferous Limestone	6	Glencoe	Drift	N. H. Winchell (boulder)
2264	"	N. Butler	Granyte	1	Prairie riv. Falls (upper)		Presented by N. Butler
2265	"	"	Quartzyte	2	Prairie riv. Falls		" "
2266	"	"	Ferruginous Sandstone	1	Pokegama Falls	Potsdam	N. Butler, (half way down the pitch of the falls.
2267	"	"	Quartzyte	1	T. 58, R. 23.		Presented by N. Butler
2268	"	"	Quartzyte	1	Sec. 1, T. 56, R. 23		" "
2269	"	"	Red Granyte	1	Sec. 3, T. 56, R. 23		" "
2270	"	"	Red Granyte	1	Sec. 34, T. 57, R. 23		" "
2271	"	"	Red Sand (same as 2266)	Indf	Pokegama Falls	Potsdam	N. Butler, (east side of Falls.)
2272	"	A. M. Hutchinson.	Wood and Peat	Indf	Near Pleasa't Gr've, Fillmore Co.	Interglac'l	Part of a log of wood 2 feet thick, found by digging a well, 45 feet below surface.
2273	"	S. D. Haskin	Pyrite on Cretaceous shale	2	Fox Lake, Martin Co.	Drift	Presented by S. D. Haskin
2274	"	"	Gold	3	" "	"	" "
2275	"	Geol. Sur	Granyte	1	Minneapolis	"	N. H. W. (from drift bank near Winslow House.
2276	"	S. D. Haskin	Fossil Wood	1	6 miles below Jackson.	"	Presented by S. D. Haskin
2277	"	E. D. Alden	Shale (Cretaceous)	1	Near Marshall, Lyon Co	"	From a bed of Fossiliferous Clay struck by digging a well, 36 feet below surface.
2278	"	"	Lignite	1	" "		Found in isolated pieces in above Clay.

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2283	1873.	C. Stewart	Favosites	1	Falls of the Ohio, Louisville, Ky	Dev	Presented by C. Stewart
2284	J'ly 17, '74	Geol. Sur	Fossiliferous Concretions	Indf	30 ms. N. of Belle Fourche, Dak	Cret	N. H. Winchell
2285	"	"	Fossil Wood	1	19 ms. N. E. of Belle Fourche, Dak	"	"
2286	A'g 28, '74	"	Bituminous slate	Indf	Near the Heart river Dak	"	"
2287	J'ly 14, '74	"	Calcite and Barite (in clay)	"	Castle Butte, Dak	"	"
2288	" 26, '74	"	Turtle remains	"	N. W. side of Short Pine Buttes, Dak	"	"
2289	" 27, '74	"	Potsdam Sandstone with Lingulepis. (See No. 2346)	"	Castle Valley, Black Hills	Potsdam	"
2290	" 1873.	C. Stewart	Favosites. (Sp. ?)	1	Falls of the Ohio, Louisville, Ky	Dev	Presented by C. Stewart
2291	1873.	"	" "	1	Falls of the Ohio, Louisville, Ky	"	" "
2295	"	"	Atrypa reticularis	2	Falls of the Ohio, Louisville, Ky	"	" "
2296	"	"	Cyathophyllum	1	Falls of the Ohio, Louisville, Ky	"	" "
2297	"	"	Zaphrentis	1	Falls of the Ohio, Louisville, Ky	"	" "
2299	"	"	Strophomena	1	Falls of the Ohio, Louisville, Ky	"	" "
2301	1872.	?	Peat	1	Unknown	Drift	
2302	"	Geol. Sur	Wood (27 feet below the surface)	1	Stillwater	"	Presented by A. Van Vorhes

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2303	1873.	Geol. Sur.........	Drillings of the Belle Plaine salt well bel. 420 ft..	Indf	Belle Plain............	....	See p. 82, 2d Annual Report....
2304	1872.	"	Quartzyte (purple, red and pink).................	5	Redstone	Potsdam...	N. H. Winchell................
2305	J'ly 29,'74	"	Micaceous Gray Quartzyte........................	1	13 ms. S. E. of camp at Box Elder Cr'k Black Hills, Dak..	....	" ....
2306	J'ly 29,'74	"	Hornblendic Gneiss........................	1	13 ms. S. E. of camp at Box Elder Cr'k Black Hills, Dak..	....	" ....
2307	1874.	"	Limestone with Acervularia (?).....	1	Twin Lakes, Freeb'n co	Drift	" ....
2308	"	"	Agatized Wood....................................	1	Fort A. Lincoln, Dak...	"	J. Becker......................
2309	J'ly 17,'74	"	Anchura biangulata. M. and H.................	1	30 miles N. of Belle Fourche, Dak.....	Cret.......	N. H. W., from No. 2284, (No. 10)
2310	"	"	Scaphites larvæformis. M. and H..............	1	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " ....
2311	"	"	Scaphites Conradi. Mort. (?) fragment...........	1	30 miles N. of Belle Fourche, Dak.....	Cret.	" " ....
2312	"	"	Limopsis striato-punctata. Ev. and Shu........	1	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " ....
2313	"	"	Nucula planimarginata. M. and H.............	1	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " ....
2314	"	"	Amauropsis paludinæformis. M. and H........	2	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " (No. 6).
2315	"	"	Vanikoro (Neretopsis) ambigua. M. and H......	1	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " ....
2316	"	"	Pteria linguiformis. Ev. and Shu...............	1	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " (No. 17)
2317	"	"	Terebratula Helena. Whitf......................	2	30 miles N. of Belle Fourche, Dak.....	Cret.......	" " (Type specimens, Nos. 14 and 26)..

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2318	J'ly 17, '74	Geol. Sur.	Actaeon concinnus. M. & H.	1	30 miles N. of Belle Fourche, Dak.	Cret.	N. H. W., from No. 2284.
2319	"	"	Pteria linquiformis. Ev. & Shu.	1	30 miles N. of Belle Fourche, Dak.	"	" " (No. 11)
2320	"	"	Anchura biangulata. M. & H.	2	30 miles N. of Belle Fourche, Dak.	"	" " (No. 24)
2321	A'g 17, '74	"	Inocevamus convexus. M. & H.	2	Slave Butte, Dak.	"	" from No. 2359, (No. 22)
2322	"	"	Scaphites Conradi. Mort.	1	"	"	" " (No. 23)
2323	A'g 15, '74	"	Buff Shale with cycloidal fish scales, vertebræ aud spines.	Indi	Near Bear Butte, Dak.	"	"
2324	J'ly 16, '74	"	(Fragments of) Baculites ovatus. Say.	2	30 miles N. of Belle Fourche, Dak.	"	" from No. 2284.
2325	J'ly 21, '74	"	(Fragments of) Gryphæa calceola. Quenst, Var. Nebrascensis. M. & H. (?)	2	Redwater Valley, Dak.	Jurassic.	" from No. 2358 (Nos. 18 and 19.
2326	A'g 10, '74	"	Internal Cast of a Terebratuloid Shell.	1	E. side of Blk. Hills, Dak.		N. H. W., from No. 2357 (No. 25)
2327	"	"	Probably Terebratula (may be Athyris).	1	E. side of Blk. Hills, Dak.		" "
2328	"	"	Cast of Ventral valve of Spirifera Centronata. Winchell.	1	E. side of Blk. Hills, Dak.		" " (No. 57)
2329	"	"	Euomphalus. (Sp. ?)	1	E. side of Blk. Hills, Dak.		" " (No. 53)
2330	"	"	Rhynchonella (fragments of.) Sp. ?	1	E. side of Blk. Hills, Dak.		" " (No. 59)
2331	J'ly 25, '74	"	Anthyris. (Sp. ?)	1	Floral Valley, Blk. Hills		" from No. 2355 (No. 42)
2332	"	"	(Fragments of Coral like) Zaphrentis	1	" "		" " (No. 41)
2333	"	"	Streptorhynchus. (Sp. ?)	1	" "		" " (No. 48)

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2334	J'ly 21,'74	Geol. Sur	Camptonectes bellistriatus. Meek	1	Redwater Valley, Dak.	Jurassic	N. H. W., from No. 2358 (No. 20)
2235	J'ly 26,'74	"	Spirifera centronata. Winchell	1	Castle Val., near Divide		" [No. 29]
2336	"	"	Syringopora (sp?)	1	" "		" [No. 30]
2337	"	"	Crinoidal column	1	" "		" [No. 28]
2338	"	"	Productus (sp?) { On the same piece of rock.	1	" "		" [No. 31]
2339	"	"	Spirifera centronata. Winchell, { On the same piece of rock.	1	" "		" [No. 32]
2340	"	"	Campophyllum or Amplexus (sp?)	1	" "		" [No. 33]
2341	"	"	Margin of a cup of a finely radiated coral, resembling Zaphrentis	1	" "		" [No. 34]
2342	Aug. 4,'74	"	Inoceramus problematicus. Schloth.	9	Spr'g Cr'k, S.E. Bl'k H'ls	Cret.	"
2343	"	"	Zaphrentis (sp?) resembles somewhat centralis. Ed. and Haine	2	" "		" [Nos. 36 and 37]
2344	"	" { On same p'ce rock	Athyris (sp?) resembles form usuall referred to A. Polsyi	1	" "		" [No. 38]
2345	"	" { On same p'ce rock	Spirifera (sp?)	1	" "		" [No. 39]
2346	J'ly 27,'74	"	Lingulepis pinnæformis. M. and H. (See No. 2289.) Obolella nana and Obolus pectenoides. Whit	Indf	Castle Val., Black Hills	Potsdam	" Type specimens of Obolus [Nos. 60, 61, 62, 63, 64 and 65] [& 35.
2347	A'g.1 ,'74	"	Matrix of Syringopora (probably mult-atteunata)	2	E. side Bl'k Hills, Dak.		N. H. W., from No. 2357 [Nos. 34
2348	Aug. 3,'74	"	Imprint of inside of ventral valve of Spirifera ?	1	French Creek, Dak.		" [No. 36] [12, 13.
2349	J'ly 17,'74	"	Terebratula Helena. Whitf	4	30 ms. N. B'le F'rche, Dak	Cret.	" f'm No. 2284, [Nos. 7.
5350	J'ly 25,'74	"	Spirifera centronata. Win	7	Floral Val., Bl'k Hills		" [Nos. 46, 47, 49, 50, 51, 52.]
2351	A'g. 10,'74	"	Spirifera centronata. Win	1	E. side Bl'k Hills, Dak.		" from No. 2357
2352	"	"	Retzia (eumetria of Hall. ? { On the same piece of rock.	1	" "		" " [No. 55.]
2353	"	"	Rhynchonella { On the same piece of rock.	1	" "		" "
2354	J'ly 11,'74	"	Siliceous Limestone (with impressions of woody fiber	6	Ludlow's Cave	Cret.	" [No. 40]

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2355	J'ly 25,'74	Geol. Sur	Fossiliferous Limestone Cont. Spirifera controna Win. Syringopora and Streptorhynchus	Indf	Floral Valley, Blk. Hills		N. H. Winchell
2356	J'ly 26,'74	"	Syringopora	1	Divide bet. Floral and Castle Valleys		"
2357	A'g 10.'74	"	Fossiliferous Limestone	Indf	E. side of Black Hills		"
2358	J'ly 21,'74	"	Fossiliferous Conglomerate	"	Redwater Valley, Dak	Jurassic	"
2359	A'g 17,'74	"	Fossiliferous Concretions	"	Slave Butte, Dak	Cretaceous	"
2360	1875.	Wm. Bull.	Argentiferous Galena	4	Clancey, Montana		Presented by Wm. Bull
2361	A'g 20,'75	G. A. Carlson	Terra Cotta Clay	1	Red Wing		Presented by C. A. Carlson
2362	M'y 22,'75	Chas. McCabe	Lignite	1	Calvert, Robinson Co., Texas		Presented by Chas. McCabe
2363	1875,	C. B. & F. A. Gordon	Kaolinized Granyte	Indf	Gordon, Renville Co., Minn		Presented by C. B. & F. A. Gordon.
2364	Nov. 1875	Geol. Sur	Octahedral Crystals of Limonite, after Pyrite	"	Lanesboro, Fillmore Co.		N. H. Winchell
2365	"	"	Crystals of Marcasite. (Pyrite)	"	" "		"
2366	1875.	H. C. Parlin	Drillings of well below 100 feet	"	Austin		Presented by H. C. Parlin
2367	"	Geol. Sur	Peat	"	St. Cloud	Drift	N. H. Winchell
2368	"	A. M. Hutchinson	Wood (from a well 28 feet below the surface)	"	Town of Beaver, S. of Spring Valley	"	Presented by A. M. Hutchinson
2369	"	Geol. Sur	Ankerite	3	Clear Grit, Fillmore Co.	St. Law	N. H. Winchell
2370	"	"	Drillings from Artesian Well	Indf	E. Minneapolis		"
2371	"	"	Well Drillings	"	Mankato		
2372	Nov. 1875	"	Limonite. Pseudomorph, after Pyrite	1	Clear Grit, Fillmore Co.	St. Law	N. H. Winchell (surface.)
2374	1875.	"	Interglacial Peat	3	Mower Co	Drift	" (50 feet below
2375	"	"	Clay (overlying No. 2374)	1	"	"	"
2376	"	"	Blue Clay (overlying No. 2375)	1	"	"	"

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2377	1875.	Geol. Sur	Cretaceous Debris	....	Lime Springs, Iowa	Drift	N. H. Winchell
2378	"	Z. Haight	Sandstone ["bedrock"]	3	Martin Co		Presented by Z. Haight, from deep well
2379	"	Geol. Sur	Trenton Limestone	1	Fountain, Fillmore Co	Trenton	N. H. Winchell, from Taylor's Quarry
2380	Aug. 1875	"	Medina Sandstone	3	Medina, N. Y	Medina	N. H. Winchell
2381	1875.	"	Cretaceous Sandstone	1	Austin	Cret	"
2382	Aug. 1875	"	Waverly Sandstone. [Cut slabs 1x2½ ft.]	2	Ohio		"
2383	1875.	"	Shakopee Limestone	1	Olmsted Co	Shak	M. W. Harrington
2384	"	"	Potsdam Limestone	1	Hinckley	Potsdam	N. H. Winchell
2385	"	"	Red Quartzyte	5	Pipestone Co		D. E. Sweet, from the Pipestone Quarry
2386	"	"	Calcite	6	Chatfield		M. W. Harrington
2387	"	"	Limestone	2	Clinton Falls, Steele Co	Trenton	M. W. Harrington, from Abbott's Quarry, Sec. 33
2388	"	"	Limestone	2	Montorville, Dodge Co.	Galena	M. W. Harrington, from a ravine, Sec. 13
2389	"	"	Limestone	1	S. side Mantorville, Dodge Co	"	M. W. Harrington, from Mantor's Quarry
2390	"	"	Limestone	2	Mantorville, Dodge Co.	"	M. W. Harrington, from bank of stream, Sec. 22 near 23
2391	"	"	Shakopee Limestone	1	Northfield	Shak	N. H. Winchell
2392	"	"	Limestone	2	Wabasha Co., nr. sec. 4, Oronoco, Olm. Co		M. W. Harrington, from bottom of quarry
2393	"	"	Limestone	1	Sec. 8, Oronoco, Olm. Co	Shak	M. W. Harrington
2394	"	"	Calcite Geodes	1	Sec. 31, High Forest Olm. Co		M. W. Harrington, William's Quarry

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2395	1875.	Geol. Sur.	Limestone	4	High Forest, Olm. Co.		M. W. Harrington
2396	"	"	Limestone	2	Root River, Olm. Co.	Galena	" A few rods W. of P. Brewers
2397	"	"	Aluminous Sandrock	1	Root River, Olm. Co.	Cret (?)	M. W. Harrington, a few rods E. of P. Brewer's
2398	"	"	Limestone	2	Rochester, Olm. Co.	Galena	M. W. Harrington, one mile E. of P. Brewer's
2399	"	"	Limestone	3	Rochester, Olm. Co.	"	M. W. Harrington, Gar'ck's Q'y
2400	"	"	Stalactitic Forms	Indf	Rochester, Olm. Co.	"	" "
2401	"	"	Limestone	3	Dodge Co.	Trenton	" Conc'd Q'r'y.
2402	"	"	Siliceous Hæmatite	1	3 or 4 ms. west Can. Falls		N. H. Winchell, [In outcrop]
2403	"	"	Sand Concretions	16	Lanesboro, Fill. Co	Jordan.	" [See 4th An. Rep.]
2404	"	"	Limestone	3	Cascade, Olm. Co.	Trenton.	M. W. Harrington, Jackson's Quarry
2405	"	"	Weathered Shale	3	Cascade, Olm. Co.	"	M. W. Harrington, Jackson's Quarry
2406	"	W. W. Folwell	Water Limestone	1	Margaretta, Erie Co., O.	Waterline.	Presented by W. W. Folwell
2407	"	Geol. Sur	Limestone (Rusty)	4	Sec. 31, High Forest, Olm. Co.		M. W. Harrington, Williams' Quarry
2408	"	"	Siliceous Concretion	1	Jordan, Fill. Co.	Drift.	N. H. Winchell
2409	"	"	Magnesian Limerock (Arenaceous)	1	Bear Creek, Rochester, Olm. Co	Shak	"
2410	"	"	Limestone	1	Sec. 7, Viola, Olm. Co.	Trenton.	"
2411	1876.	Centennial Ex.	Limestone (Drilled by Diamond Drill)	1			Drilled in Machinery Hall, and presented by Diamond Rock Boring Company
2412	1872.	Geol. Sur.	Hone-Stone	1	Austin	Cretaceous	N. H. Winchell, manufactured at Austin

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2413	1876.	Centennial Exb...	Amethyst, [cut].........	1	Lake Superior.........	....	A. E. Foote.........
2414	"	" ...	Micaceous Magnetite.........	1	Crown Point, N. Y......	....	N. H. Winchell.........
2415	"	" ...	Kaolinite.........	Indf	Huron, Lawr'e Co., Ind.	....	" ....
2416	Dec. 1876	S. F. Peckham....	Talc. [Nacrite].........	1	Lime Rock, R. I.........	....	Presented by S. F. Peckham...
2417	"	"	Granyte.........	10	Smithfield and Cumberland, R. I......	....	" " ...
2418	"	"	"Granyte".........	1	Westerly, R. I.........	....	" " ...
2419	"	Chas. McCabe....	Novaculite.........	2	Hot Springs, Ark.......	....	" Chas. McCabe...
2420	1877.	H. P. Van Cleve..	Beach-sand.	Indf	Sandwich Islands......	....	" H. P. Van Cleve.
2421	1875.	Geol. Sur.........	Impure Hæmatite [and Jasper].........	1	2 miles N. E. Spring Valley.........	Drift..	John Kleckler.........
2422	"	"	Amy daloid.........	1	N. shore of L. Superior.	....	N. H. Winchell.........
2423	"	"	Limestone.........	1	Sec. 13, Wasioja, Dodge Co.........	....	M. W. Harrington.........
2424	"	"	Limestone.........	1	Sec. 6, Marion, Olm. Co.........	Trenton...	M. W. Harrington, Ireland & Crosier's Quarry.........
2425	"	"	Limestone.........	1	Wasioja, Dodge Co.....	Galena....	M. W. Harrington, Blake's Mill.........
2426	"	"	Calcareous tufa.........	1	Fillmore Co.........	Drift	N. H. Winchell.........
2427	"	"	Travertine.........	5	Section 10, Milton, Dodge Co.........	"	M. W. Harrington, Irish's Kiln.........
2428	"	"	Limestone.........	4	Sec. 8, Oronoco, Olm Co.........	Shak......	M. W. Harrington. Barrett's Quarry.........
429	Dec. 1876	S. F. Peckham....	Gray Marble.........	2	Rhode Island.........	....	Presented by S. F. Peckham...
2430	"	"	White Marble with magnesean band.........	1	"	....	" " ...
2431	"	"	Saccharoidal Marble.........	2	"	....	" " ...
2432	"	"	Calcite with Amphibole.........	1	"	....	" " ...

Catalogue of the Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2434	Oct. 1872.	Geol. Sur	Lamellar Calcite	3	St. Charles, Win. Co	Drift	N. H. Winchell, from "St. Peter slope."
2435	1876.	"	Surface Soil [Loam]	Indf	Sec. 32, Yucatan, Houston Co		"
2436	"	"	Surface Soil [Loam]	"	Sec. 35, Blackhammer, Houston Co		"
2437	"	"	Gravel	"	Bloomfield, Fill. Co		From a Cretaceous Beach, Land of Peter Peterson, SW. ¼, Sec. 15.
2438	"	"	Calcite	2	Near Caledonia, Houston Co		N. H. W. From "Saint Peter Slope."
2439	"	"	Limonite [Pseudomorph after Pyrite]	1	Caledonia, Houston Co.	Shak	N. H. Winchell
2440	"	"	Fossiliferous Limestone	3	Dayton, Hennepin Co	Drift	N. H. Winchell. From boulders at Gula's Limekiln
2441	"	"	Siliceous Fossiliferous Concretions	Indf	Sec. 19, Union, Houston Co	Shak	N. H. Winchell
2443	"	"	Shale, with Dikellocephalus	Indf	Hokah, Houston Co	St. Croix	"
2444	1875.	"	Bog Ore	3	Etna, Fillmore Co		"
2445	"	"	Iron Ore	3	Vermilion L., Minn		
2446	"	"	Clay	2	Near Spring Valley	?	N. H. Winchell. [On David Higby's land.]
2447	"	"	Red jasper	1	2¼ ms. NE. of Spring Valley	Drift	Presented by J. Kleckler
2448	J'ly 13,'75	"	Red jasper	1	Spring Valley	"	Presented by P. W. Thayer
2451	1875.	"	Saccharoidal Sandstone	1	Sec. 8, Oronoco, Olm. Co	Low. Mag.	M. W. Harrington. Barretts'
2452	"	"	Bituminous Shale	Indf	Dubuque, Iowa	Maquok'ta	N. H. Winchell
2453	"	"	Shell Marl	2	Galesburg, Mich	Drift	"
2454	1872.	J. F. Kenworthy	Pecopteris villosa	4	Mazon Creek, Grundy Co., Ill		Records in Doubt

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained.		NAME.	No. of specimens.	Locality.	Formation	Collector and Remarks.
	When.	Where.					
2455	1872.	Geol. Sur	Cretaceous clay	1	Austin	Cret	N. H. Winchell
2456	1879.	"	Linomite [after Pyrite]	1	Wabasha	Low Sil	"
2457	1876.	Jas.D.Hutchinson	Cannel Coal	1	Pennsylvania	Carb	Presented by Jas. D. Hutchinson
2458	"	"	Talc	1	Vermont		Presented by Jas. D. Hutchinson
2459	"	"	Tellurium	1	Colorado		Presented by Jas. D. Hutchinson. [Humboldt Mine]
2460	"	"	Chalcopyrite	1	Stratford, Orange Co., Vt		Presented by Jas. D. Hutchinson
2462	"	"	Sand Concretions	2	Sharon, Windsor Co. Vt		Presented by Jas. D. Hutchinson
2463	"	"	Graphite	1	Chelsea, Orange Co., Vt		Presented by Jas. D. Hutchinson
2464	"	"	Mica	1	Chelsea, Orange Co., Vt		Presented by Jas. D. Hutchinson
2465	"	"	Ophiolyte	1	Roxbury, Vt		Presented by Jas. D. Hutchinson
2466	"	Geol. Sur	Roofing Slate	7	Thomson		N. H. Winchell
2467	"	"	Dendrites on lithographic stone	1	Solenhofen, Bavaria		Presented
2468	"	Minnie Bolles	"Tennessee Marble	1	Tennessee		
2469	Oct. 1876	Geol. Sur	Unio	...	Minneapolis		N. H. Winchell. From the brick-clay
2470	"	"	Planorbis, &c	....	"		N. H. Winchell. From marl overlying brick-clay
2471	"	"	Cretaceous debris	Indf	Hennepin Co	Drift	N. H. Winchell
2472	1876.	A. N. Fuller	Fluorite	1	Silverton, Colorado		From San Juan Mines

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2473	1876.	A. N. Fuller	Argentiferous Galena	1	Silverton Col		From San Juan Mines.
2474	"	"	Cubical Pyrites	1	"		" "
2475	"	"	Argentiferous Galena	4	"		" "
2476	"	"	Stephanite ["Brittle Silver"]	2	"		" "
2477	"	"	Quartz [Crystalized]	1	"		" "
2478	1877.	W. A. Brownell	Petrified Wood	4	Near So. Park, Col.		
2479	"	"	Endoceras proteiforme. Hall	2	S. Rutland, Jeff. Co. N. Y.	Utica	
2480	"	"	Graptolite	3	" "	"	
2481	"	"	Triarthus Beckii	2	" "	"	
2484	"	"	Fetid Limestone	1	Gr't. Bend, Jeff. Co., N. Y.	Trenton	
2490	1876.	Centen. Exhibit'n.	Red Hæmatite	2	Athens, Tenn		Presented by the Tennessee Centen. Com
2491	"	"	Red Hæmatite	1	Rockwood, Tenn		Presented by the Tennessee Centen. Com
2492	"	"	Red Hæmatite	1	Riceville, Tenn		Presented by the Tennessee Centen. Com
2493	"	"	Limonite	2	Stewart Co., Tenn		Presented by the Tennessee Centen. Com
2494	"	"	Limonite	2	Johnson Co., Tenn		Presented by the Tennessee Centen. Com
2495	"	"	Limonite	1	Anderson's Sta. N. Ga.		Presented by the Tennessee Centen. Com
2496	"	"	Hausmannite [Manganese, Black oxide, impure]	1	Cooke Co., Tenn		Presented by the Tennessee Centen. Com
2497	1875.	Geol. Sur	Agate	1	High Forest, Olm. Co.	Drift	N. H. Winchell
2498	"	"	Limonite		SE. ¼, Sec. 8, Bloomfield, Fill. Co	Cret. ?	N. H. Winchell. From C. C. Temple's well

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2499	1875.	Geol. Sur.	Ferruginous crag	1	Etna, Fillmore Co.	Drift.	N. H. Winchell
2500	"	"	Clay Slate	2	Thomson	Huronian	"
2501	1876.	Centennial Exb.	Linonite. ["Pipe Ore"]	2	McMinn Co., Tenn.		Presented by Tennnessee Centen. Com.
2502	"	"	Magnetite	2	Mitchell Co., N. C.		Presented by the Tennessee Centen. Com.
2503	"	"	Smithsonite	3	Union Co., Tenn.		Presented by the Tennessee Centen. Com.
2504	"	"	Barite	1	Cooke Co., Tenn.		Presented by the Tennessee Centen. Com.
2505	"	"	Coal	2	Poplar Creek, Tenn.		Presented by the Tennessee Centen. Com.
2506	"	"	Coking Coal	1	Nr. Chattanooga, Tenn.		Presented by the Tennessee Centen. Com.
2507	"	"	Fossiliferous Hæmatite	3	Rockwood, E. Tenn.		Presented by the Tennessee Centen. Com.
2508	"	"	Talc. [Steatite]	1	Fairfax Co., Va.		N. H. Winchell
2509	"	"	Linomite	2	Ironton, Wis.	"Potsdam"	"
2510	"	"	Red Marl. [Fire clay]	Indf	Lick, Grayson Co., Ky.		From the Kentucky Geol. Survey
2511	"	"	Washed China-clay	"			From the American Kaolin Co., Philadelphia.
2512	"	"	Kaolin	1	Lick Mountn, Wythe Co., Va.		N. H. Winchell
2513	"	"	Kaolin. [Fire clay]	1	Chattanooga, Tenn.		From the Tennessee Centen. Com.
2514	"	"	Phosphatic nodules	3	Chisholm's I., S. C.	Cretaceous	From the Pacific Guano Co.
2515	"	"	Washington Coke	Indf	Letonia, Ohio		From the Cherry Valley Iron Co.

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Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2516	1876.	Geol. Sur	Brick clay	Indf	Shingle Creek, Minneapolis	Drift	N. H. Winchell
2517	"	"	Crag	1	Crow River, Hennepin Co	"	"
2518	"	"	Calcite	2	Caledonia, Houston Co.	St. Law.	"
2519	"	"	Debris from local drift	5	Nr. Caledonia, Houston Co	Drift	"
2521	"	"	Linomite. [Pseudomorph after Pyrite]	3	Caledonia, Houston Co.	Shak.	"
2522	"	"	Linomite. [Pseudomorph after Pyrite]	1	Crooked Creek Valley, Houston Co.	"	W. D. Belden
2523	"	"	Fossiliferous chert	14	Caledonia, Houston Co.	"	N. H. Winchell
2524	"	"	Straparollus	1	Caledonia, Houston Co.	"	Horace V. Winchell
2525	"	"	Sand concretions	2	Houston, Houston Co.	St. Croix	N. H. Winchell
2526	J'ly 13,'76	"	Fossiliferous chert	9	Sec. 4, Canton, Fillmore Co	Drift	N. H. W. [In loam near top of Lower Trenton terrace.]
2527	1876.	"	Fossiliferous limestone [slab]	1	Spring Grove, Fillmore Co	Trenton	N. H. Winchell
2529	J'ly 15,'76	"	Sandy loam	....	Sec. 30, Money Cr'k, Houston Co.	Loam	N. H. W. [Near Fox & Perkins mill
2530	1876.	"	Clay loam	....	Sec. 30, Money Cr'k, Houston Co.	"	N. H. W. [Near Fox & Perkins mill.
2531	"	"	Decaying mica schist	Indf	Eden Prairie, Hennepin Co.	Drift	N. H. Winchell
2532	"	Centennial Exb.	Linomite	1	Shelby Furnace, Ala.		Selma, Rome & Dalton R. R.
2533	"	"	"	1	Tecumseh Furnace, Ala.		" "
2534	"	"	Limestone	1	Tecumseh Furnace, Ala.		" "
2535	"	"	"	1	Woodst'k Furnace, Ala.		" "

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2536	1876.	Centennial Exb...	Iron ore	1	"Amberson's," Ala		Selma, Rome & Dalton R. R.
2537	"	"	Peacock Copper ore	1	Stone Hill, Ga.		" "
2538	"	"	Charcoal	1	Stonewall, Ga		" "
2539	"	"	Pine Charcoal [made in ovens]	2	Shelby Furnace, Ala		" "
2540	"	"	Magnetite	Indf	Port Henry, N. Y		From the New Bed Mine
2541	"	"	Barite	1	Mineral Point, Wis	Galena	Wisconsin Geol. Sur
2542	"	"	Linomite	2	Nr. Chattanooga, Tenn.		Tenn. Commissioners
2543	"	"	Linomite, [bog ore]	2	Vernon Co., Wis	"Potsd'm"	Wisconsin Geol. Sur
2544	"	"	Smithsonite	1	Mineral Point, Wis.	Galena	" "
2545	"	"	Fossiliferous Hæmatite	3	Mayville, Wis	Clinton	" "
2546	"	"	Serpentine rock	1	Near Philadelphia, Pa.		The University of Penn. is built of this
2547	"	Geol. Sur	Dressed limestone	1	Rochester, Minn	Trenton	Presented by W. D. Hurlbut
2548	"	"	Dressed Kasota stone	2	Kasota	Shakopee	Presented by Downs Bros
2549	"	"	St. Lawrence limestone	....	St. Lawrence	St. Law	N. H. W., filled with greensand
2550	"	"	Limestone boulders	1	"	Drift	"
2551	"	"	Quicklime	Indf	"	"	" burnt from No. 2550.
2555	"	"	Cretaceous debris	"	Minnetrista, Hennepin Co.	"	"
2556	"	Centennial Exb...	Washed Kaolin	"	Grand Rapids, Wis	Laurent'n.	Wisconsin Geol. Sur
2557	"	"	Unwashed Kaolin	"	" "	"	" "
2558	Aug. 1877	Geol. Sur	St. Peter Sandstone	1	St. Paul, [Dayton's bluff]	St. Peter	N. H. W., eaten by lithodomous molluscs
2559	1877.	"	Limestone	1	St. Andrew's Rapids, Manitoba		N. H. W., 12 miles below Winnipeg
2560	June 1877	"	Selenite [crystals]	Indf	Fort Abercrombie, Dak		N. H. Winchell
2562	Aug. 1877	"	Fossiliferous slabs	"	St. Paul	Trenton	"

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2563	1877.	Geol. Sur.	Organic forms [?]	8	Northfield, Rice Co.	Shakopee.	N. H. Winchell
2564	"	"	Combustible shale	8	Prairie Creek Quarries, Rice Co.	Trenton	"
2565	Oct. 1877	"	Slate [a variety of]	1	Thompson Junction	Huronian.	"
2566	1877.	"	Dendrites on limestone	1	Mineral Hill, 4 ms. above Deadwood, Dak.		
2567	A'g 13, '77	N. Butler	Auriferous slate	1	Near Lead City, Blk. Hills		Presented by N. Butler
2569	1877.	Geol. Sur.	Wood. [F.om 40 ft. below the surface]	5	4 miles W. of Little Falls, Morrison Co	Drift	Presented by T. E. Doten
2570	A'g 18, '77	"	Native copper	1	Lake Superior		Presented by Emil Munch
2571	"	"	Argentiferous Galena	1	Black bay, N. shore Lake Superior		" "
2572	"	"	Magnetite	1	Negaunee, Mich.		" "
2573	"	"	Hæmetite	1	" "		" "
2574	1877.	"	Red Sand	Indf	Lakeland, Wash. Co.	Drift	N. H. Winchell
2575	Aug. 1877	"	Red Paint-clay	"	Afton, Wash. Co.	"	"
2578	"	"	Chaetetes, &c.	"	Dayton's bluff, St. Paul.	Trenton	"
2579	1877.	"	Glass-sand	"	Red Wing, Goodhue Co.	St. Croix	"
2580	1872.	J. W. Pomeroy	"Blossom Rock"	8	Boulder Co., Colorado		Presented by J. W. Pomeroy
2581	"	"	"Decomposed Quartz"	1	" "		" "
2582	1877.	Geol. Sur.	Green-sand rock	1	Red Wing, Goodhue Co.	St. Croix	N. H. Winchell
2583	1872.	J. W. Pomeroy	Minerals accompanying gold and silver	Indf	Colorado		Presented by J. W. Pomeroy
2584	"	"	Pyrite and Quartz	2	Gregory Mine, Col.		" "
2585	"	"	Surface Quartz containing gold	2	Columbia Mine, Col.		" "
2586	"	"	Chalcopyrite, Bornite and Pyrite containing gold	1	" "		" "

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2587	1872.	J. W. Pomeroy....	Pyrite..........	1	Gold Hill, Colorado....	....	Presented by J. W. Pomeroy..
2588	"	"	Pyrite in grit.	1	" "	....	" " ..
2589	1877.	Geol. Sur.........	Potter's clay..........	Indf	Section 3 Goodhue, Goodhue Co.......	....	N. H. Winchell........... ...
2590	"	"	Terra-cotta clay..........	"	Red Wing, Goodhue Co	....	" ....
2591	"	"	Green sand..........	"	" "	St. Croix..	" ....
2592	"	"	Green sandstone.	2	Hay Creek, Goodhue Co	" ..	" ....
2594	"	"	Organic forms[?]..........	7	Soren's bluff, Red Wing	St. Law...	" ....
2598	Nov, 1876	Geo. F. Kunz.....	"Clay stones"..........	Indf	Franklin, N. J..........	....	....
2599	"	"	"	"	Long Meadow, Mass...	....	....
2600	"	"	Talc..........	3	Staten Island, N. Y.....	....	....
2601	"	"	"Horse bone Tufa".........	2	Watertown, N. Y.......	Drift	....
2602	"	"	Waterline cement rock..........	1	Rondout, N. Y.........	Silurian...	....
2603	"	"	Shales.	5	Catskill Falls, N. Y.....	" ...	....
2604	"	"	Compact, massive sphalerite..........	1	Bethlehem, Pa...	....	....
2605	"	"	Trap dyke in gneiss..........	1	Mt. Tom, Mass..........	Igneous....	....
2606	"	"	Quartzyte Conglomerate..........	9	Morristown, N. J.......	....	....
2607	1877.	Geol. Sur.........	Siliceous concretions in sandrock..........	1	Goodhue Co...........	St. Croix..	N. H. Winchell........... ....
2608	1873.	A. F. Lounsberry.	Silicified wood..........	5	Bismark, Dak..........	....	Presented by A. F. Lounsberry
2609	"	" ..	Gypsum..........	10	"	Cretaceous	" "
2610	"	" ..	Lignite..........	6	"	"	" "
2611	"	" ..	Slag [from burning of lignite]..........	2	"	....	" "
2612	1876.	" ..	Quartz gangue with chalcopyrite. [No. 29]......	1	Kellogg Mines, Pulaski Co., Ark.....	....	Little Rock & Fort Smith R. R.
2613	"	W. E. Rowell......	Sulphide of lead. [No. 30]..........	1	Kellogg Mines, Pulaski Co., Ark.....	....	" "
2614	"	"	Galenite and sphalerite in slate. [No. 31].......	1	Kellogg Mines, Pulaski Co., Ark.....	....	" "

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2615	1876.	W. E. Rowell.....	Zinc Blende. [No. 32]...........	1	Kellogg Mines, Pulaski Co., Ark	....	Little Rock & Fort Smith R. R.
2616	"	"	Chalcopyrite with sulphuret of silver and siderite. [No. 33]..	1	Kellogg Mines, Pulaski Co., Ark.....	....	" "
2617	"	"	Spathic iron. [No. 34]........	1	Kellogg Mines, Pulaski Co., Ark.....	....	" "
2618	"	"	Magnetic iron ore. [Nos. 35 and 36]..........	2	Magnet Cove, Ark.......	....	" "
2620	"	"	Linomite. [No. 37].........	3	Pope County, Ark......	....	" "
2621	"	"	Slate ore. [No. 38].........	1	Franklin County, Ark..	... .	" "
2622	"	"	Carb. of iron. [No. 39].........	1	Sebastian County Ark..	....	" "
2623	"	"	Kaolin. [No. 40].........	1	Pulaski County, Ark...	....	" "
2624	"	"	Novaculite. [No. 41].........	1	Hot Springs, Ark........	....	" "
2625	1877.	Geol. Sur.........	Subsoil.........	...	Sec. 28, Beaver Cr'k, Rock Co., Minn...	Drift	N. H. Winchell.................
2626	Oct.25,'77	"	Drift clay.........	....	Sec. 28, Beaver Cr'k, Rock Co., Minn...	"	N. H. Winchell. [40 feet below the surface]...........
2627	1877.	"	Surface clay.........	....	Sec. 28, Beaver Cr'k, Rock Co., Minn...	"	N. H. Winchell.................
2628	"	"	Subsoil [loam].........	....	Sec. 28, Beaver Cr'k, Rock Co., Minn...	"	" ....
2629	"	Dr. J. C. Rosser. .	Petrified wood. [Bored by Teredo?]............	1	Dakota................	....	Presented by Dr. J. C. Rosser..
2630	"	" ...	Fossiliferous concretion. [Inoceramus, &c].....	1	"	Cretaceous	" " ..
2631	"	"	Calcite. [Group of crystals].........	1	From a cave near Deadwood, Dak..	....	" " ..
2632	Sept. 1877	Geol. Sur.........	Limestone. [The building stone layers].........	Indf	Minneapolis............	Trent......	N. H. Winchell.................
2633	Nov. 1876	Geo. F. Kunz.....	"Trap crystals".........	6	Bergen Hill, N. J.......	Igneous ...	....
2634	1877.	Hugh T. Douglas..	Brown hæmatite. [Nos. 1, 2, 3, 4—A]............	Indf	Warren Co., Va.........	Silurian. ..	Presented by Hugh T. Douglas

Catalogue of Specimens Registered in the Generat Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2635	1877.	Hugh T. Douglas..	Trenton limestone	2	Warren Co., Va	Trenton	Presented by Hugh T. Douglas
2636	"	"	Talcose slate	2	Farquier Co., Va	Huronian	" "
2637	"	"	"Syenite"	2	"		" "
2638	"	"	Greenstones	2	"		" "
2639	"	"	Magnetic iron ore	5	"		Presented by Hugh T. Douglas. From surface of Lodestone Ridge
2640	"	"	Magnetic iron ore	1	"		Presented by Hugh T. Douglas. From Slater's mine
2641	"	"	Calcacrous tufa	1	Clark's Co., Va		Presented by Hugh T. Douglas. Near Shenandoah river
2642	"	"	Calcareous tufa	1	"		Presented by Hugh T. Douglas. 3 miles below Berry's Ferry
2643	"	"	Magnetic and specular iron ore	2	Lodestone Ridge, Farquer Co., Va		Presented by Hugh T. Douglas. From Slater's Mine
2645	"	"	"Jaspery Rock"	2	Lodestone Ridge, Farquer Co., Va		Presented by Hugh T. Douglas
2646	"	"	Jaspery hæmatite. [Said to contain Magnetite and Chromium	2	Lodestone Ridge, Farquer Co., Va		Presented by Hugh T. Douglas. From surface at Slater's Mine
2647	"	"	Jaspery iron ore	1	Blue Ridge, Warren Co., Va		Presented by Hugh T. Douglas
2648	"	"	"Decomposing Rock"	1	Warren Co., Va		Presented by Hugh T. Douglas. Foot hills of Blue Ridge, 5 miles S. of Front Royal

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2649	1877.	Hugh T. Douglas.	Barite	5	Farquier Co., Va.	Triassic	Presented by Hugh T. Douglas. 2 miles N. of Catlett.
2650	"	Wyand'te Rig Mls	Hæmatite ore	1	Jackson Co., Mich.	Huronian	
2651	"	Hugh T. Douglas	Mineral supposed to cont'n sulphuret of antimn'y	1	Warren Co., Va.		Presented by H. T. Douglas
2652	"	"	Fragments of Jaspery specular iron ore	9	Farquier Co., Va.		Presented by H. T. Douglas, Lodestone Ridge
2654	"	"	Magnetic iron ore. Jaspery hæmatite	1	"		Presented by H. T. Douglas
2655	"	"	Glass sand	Indf	Prince William Co., Va		Presented by Hugh T. Douglas. 38 miles from Alexandria
2656	"	"	Compact flexible sandstone	"	" "		Presented by Hugh T. Douglas. 38 miles from Alexandria
2657	"	"	Decomposing Rock associated with Graphite No. 2658.	"	Warren Co., Va.		Presented by Hugh T. Douglas
2658	"	"	Graphite	"	Warren Co., Va., 4 miles S. of Front Royal	Potsdam?	" "
2659	"	Wyand'te Rig Mls	Fossiliferous hæmatite	1	Dodge Co., Wis.	Clinton	
2660	"	" "	Massive hæmatite	1	Marquette, Mich.	Huronian	
2661	"	" "	Magnetite	1	Michigamme, Mich.	"	
2662	"	" "	"	1	Republic Mine, Mich.	"	
2663	"	" "	"	1	Barnum Mine, Mich.	"	
2664	"	" "	"	1	Champion Mine, Mich.	"	
2665	"	Geol. Sur.	Fossiliferous limestone. [Faribault marble.] [No. 1]	1	3 miles E. of Faribault	Trenton	L. B. Sperry. Upper stratum, Cronier's quarry
2666	"	"	Fossiliferous limestone. [No. 2]	1	" "	"	L. B. Sperry. Deeper strata, Cronier's quarry

Catalogue of Specimens Registered in the General Museum in 1878—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2667	1877.	Geol. Sur.	Pyritiferous blue limestone, [No. 3]	1	Rice Co.	Trenton	L. B. Sperry. Deeper strata of the Trenton
2668	"	"	Trenton limestone. [No. 4]	1	Sec. 9, Wheeling, Rice Co.	"	L. B. Sperry. Prairie Creek quarry
2669	"	"	Fucoidal argillaceous deposit. [No. 5.] Combustible	1	Sec. 9, Wheeling, Rice Co.	"	L. B. Sperry. Prairie Creek quarry. [2 in. thick]
2670	"	"	Crag. [No. 6]	1	Ravine nr. Asylum, Faribault	Drift	L. B. Sperry
2671	"	"	Iron stained St. Peter sandstone. [No. 7]	Indf	Faribault	St. Peter	"
2672	"	"	Blue clay, deep subsoil. [No. 8]	"	Eastern part of Rice Co	Drift	L. B. Sperry. Characteristic in E part of Rice Co.
2673	"	"	Prairie loam. [No. 9]	"	" "	"	L. B. Sperry. Characteristic in E. part of Rice Co.
2674	"	"	Blue clay. [No. 10]	"	Western part of Rice Co	"	L. B. Sperry. Characteristic of W. part of Rice Co.
2675	"	"	Yellow sandy clay. [No. 11]	"	" "	"	L. B. Sperry. Characteristic of W. part of Rice Co.
2676	"	"	Soil. [No. 12]	"	Eastern part of Rice Co	"	L. B. Sperry. Characteristic of E. part of Rice Co.
2677	"	"	Consolidated blue clay. [No. 13]	"	Sec. 8, Forest, Rice Co.	"	L. B. Sperry. 20 ft. below the surface
2678	"	"	Lignite. [No. 14]	"	W. part of Rice Co.	"	L. B. Sperry. Occasionally found in deep wells
2679	"	"	Drift. [No. 15]	"	S. W. part of Rice Co.	"	L. B. Sperry. Characteristic of S. W. part of Rice Co.
2680	"	"	Fragment of boulder. [No. 16]	1	Near Cannon Falls, Rice Co.	"	L. B. Sperry

Catalogue of Specimens Registered in the General Museum in 1878.—Continued.

Serial Number.	Obtained. When.	Obtained. Where.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
2681	1877.	Geol. Sur	Slate	5	Little Falls, Morrison Co	Huronian	N. H. Winchell
2682	"	"	Concretions in the slate	4	Little Falls, Morrison Co	"	"
2684	"	"	Mica schist	1	Little Falls, Morrison Co	"	"
2685	"	"	Mica schist	1	Near Little Falls, Morrison Co	"	" Mouth of Little Elk river
2688	Sept. 1877	"	Staurolite	Indf	Pike Rapids, Morrison Co	"	N. H. Winchell
2689	"	"	Staurolite mica schist	22	Pike Rapids, Morrison Co	"	" Near the mouth of Swan River
2690	"	"	Quartzyte? From the slate	2	Pike Rapids, Morrison Co	"	N. H. Winchell
2691	"	"	Orthocerata	Indf	Wanamingo, Goodhue Co	Trenton	"

APPENDIX A.

The following are the full instructions of the Executive Committee given to Prof. Peckham, after amendment so as not to come into conflict with the plans of the State Geologist. The specimens gathered during the progress of the examinations of Prof. Peckham, tendered to the General Museum by him in his report, were subsequently otherwise disposed of by him, and have never been placed in the care of the Curator.

Resolved, That Prof. S. F. Peckham be instructed to proceed as soon as possible after the first of June next, and by the cheapest conveyance, to Grand Portage, Minn., and establish there an assay office, in the best accommodations that he can secure, to remain until about September 1st.

He shall use such apparatus as the University now possesses, and shall procure, in addition, such apparatus as may be necessary.

He shall assay any ores that may be brought to him, requiring in all cases pre-payment of the following named sums: for any nnmber of assays less than three (3) four dollars each; for three (3) assays for the same party and at the same time, ten dollars; for four (4) or more assays for the same party at the same time, three dollars each.

Any parties who will make affidavit that they are citizens of the State of Minnesota, and that their ores are found in Minnesota, giving the locality where the ores were found, as nearly as possible, and certifying their willingness that the results may be published, shall be charged one-half the above mentioned prices. Specimens submitted by the State Geologist, shall be assayed free of cost to private parties, and a report of the same and all other assays and investigations, not for private parties, shall be made direct to the State Geologist.

Payment for assays may be made in specimens of minerals or ores at Prof. Peckham's valuation.

Prof. Peckham shall advertise in the St. Paul Pioneer Press and in the Duluth ——— immediately, and about May 20th, that he intends to go to Grand Portage, and shall also procure the printing of fifty posters, which he shall cause to be posted in conspicuous places in Minneapolis, St. Paul and Duluth.

On his return, he shall make a report to the President of the University, for this committee, in which he shall show all receipts and disbursements made for the University, with any other information that he may consider of value to this committee.

He shall secure the services of Mr. Bowman as his assistant, at a rate not to exceed thirty dollars per month and his expenses.

The sum of two hundred dollars, or so much of it as may be necessary, is hereby appropriated for the use of Prof. Peckham in providing additional apparatus, and such miscellaneous expenses as may be necessary.

Specimens gathered in the course of these examinations, shall be placed in the General Museum, but a series suitable to the Museum of Technology, may be placed there after the General Museum has been supplied.

APPENDIX B.

MICROSCOPIC ENTOMOSTRACA,

BY C. L. HERRICK, *Laboratory Assistant.*

NEW HAVEN, JANUARY 8, 1879.

Prof. N. H. Winchell:

DEAR SIR: I have examined the chapter by Mr. Herrick, which you placed in my hands, and think it a valuable contribution to science. It will make a very appropriate addition, it appears to me, to the Minnesota State Report, because of its illustrating with well-drawn figures and good descriptions the life of the fresh water of the State. The species are among the most interesting of the minuter animals of the waters, and have a wide distribution over the globe.

Yours truly,

JAMES D. DANA.

MINNEAPOLIS, MINN., JANUARY 14, 1879.

Gen. H. H. Sibley, President of the Board of Regents:

I herewith communicate to the Regents an illustrated memoir on the microscopic crustaceans of fresh waters of Minnesota, as a contribution on the Natural History of the State, in accordance with law. This valuable paper, by Mr. C. L. Herrick, my laboratory assistant, has cost the Survey nothing more than the use of its rooms and apparatus, and has been submitted to the approval of Prof. J. D. Dana of New Haven, who indorses it as a valuable contribution to science, and recommends its publication.

Very respectfully,

N. H. WINCHELL.

PREFACE.

It is with the hope that the following paper may be of service to some who, like myself, were interested in the many and varied forms found in every stagnant pool as well as in the lakes and ponds of our country, but who were unable to find any connected account of them, that it is offered to such, as a contribution toward a better understanding of a little known order of the natural kingdoms.

The lakes within a radius of ten miles of Minneapolis have furnished all the material examined, and the supply is not exhausted by any means. It is only hoped to so outline the extent and limits of this division of animal life that it will be less difficult to place the forms found from time to time, in approximately their true position.

With very few exceptions, as far as has been ascertained, no one has devoted any attention to the fresh water *Entomostraca* of America, and it is necessary for some one to act as a pioneer, to learn whether any of the forms described in Europe appear here, and to discover, if possible, if there be a general similarity between these widely separated faunæ. This has been the ambition of the present writer; and if only an intelligent attention be directed to this field, he will feel abundantly repaid for the attempt.

The works consulted were Dana's "Report of the Crustaceans collected during the Wilkes Exploring Expedition to the Pacific Ocean", Dr. W. Baird's "British Entomostraca," "Report of U. S. Fish Commission," papers in "Hayden's Survey of the Territories", and papers in the American Naturalist and other periodicals. Many thanks are due to Prof. N. H. Winchell, director of the State Geological Survey, for assistance and advice in many ways; to President W. W. Folwell, and Dr. P. L. Hatch, for assistance and intelligent sympathy, and to fellow members of the "Naturalist's Club."

That there will be found mistakes in the work is to be expected, but it is hoped that the information will be reliable in the main.

It is not without hesitation that, as a novice in scientific investigation, names are suggested for the new species found, but the purpose of this paper will be best served by defining as well as possible these forms, and submitting them to the test of further study; and if in the future more experience and greater research can be brought to bear upon this domain, these preliminary notes will perhaps not be without their value. The drawings were all made by the writer, in most cases from life, though some details have been introduced from the works consulted, and the plate of *Phyllopoda* was collected from the government reports and elsewhere. Clearness in outline and detail rather than beauty in execution was the desideratum.

C. L. HERRICK.

INTRODUCTION.

ENTOMOSTRACA.

The name was derived from two Greek words meaning insect and shell, by Otho F. Muller, and applied by him in his "*Entomostraca*" (1785) to the animals which had hitherto been all comprised in Linnæus' genus *Monoculus*, named from the supposition that they all possessed but one eye. The name "*Branchipodes*" was also proposed, and would have been appropriate enough, but Muller supposed that the branchial appendages which suggested the name, were wanting in *Cythere*, etc. Muller, aside from naming the group, was the first to arrange these animals in anything like a systematic classification, and collected a great deal of interesting information. Since his time several authors have written upon these interesting animals in Europe, but with a few exceptions no systematic work on Entomostraca has appeared in English.

Dr. W. Baird published in 1850 a superb work on the Entomostraca of Great Britain. which is still the best thing in the English language. But since this work was published, many additions have been made to our knowledge. In Prof. J. D. Dana's magnificent work on the Crustacea found in the "Wilkes Exploring Expedition", many new species are described, and a revised classification for the whole order is proposed. In this work every known genus was characterized. Since then additions of new speciés have been published by various authors, and are scattered through the reports of various societies. Moreover, recent studies in Embryology have thrown new light on the classification of all the lower animals, and many changes are necessary, but it is not possible at this stage of the study to attempt a

SYSTEMATIC ARRANGEMENT

of this order. We shall follow quite closely Dana's system as being most complete.

The following changes, which will not affect essentially the nomenclature used must be indicated as the necessary result of modern research:

1. The *Merostomata*, or King Crab group, which contains the modern genus *Limulus* (Horseshoe Crab) and the ancient *Eurypteridæ*, etc., which was considered by Dana a sub-order of Entomostraca has by recent writers been regarded as a distinct order intermediate between the *Trilobita* (which Dana included with the sub-classes *Chorestopoda* and *Entromostraca* in the class *Edriophthalmia* or *Tetradecapoda*) and the *Entomostraca*.

Trilobita now stands at the foot of the sub-kingdom, its inferiority in rank being assumed from the inferiority in point of time.

The *Cormostomata* (including *Pœcilopoda* or *Epizoa*) has been united with *Copepoda (Cyclopacea)* thus doing away with the sub-orders in Entomostraca.

The *Pectostraca* (including *Phizocephala* and cirripeda (barnacles) have been assigned a place among the Entomostraca from facts learned regarding their development. These crustaceans have been tossed from one division to another till they ought, it would seem, to find a permanent resting place. First considered mollusks, they have now taken their position among the lower crustaceans. These creatures, which are at maturity firmly cemented to foreign bodies, and are inclosed in a hard shell-like test have, in their earlier stages, forms resembling the "Nauplis" stage of *Cylops* (see plate III.) and also a stage resembling the mature *Cypris*.

It is now known that, as Huxley expresses it, "the barnacle is a crustacean fixed by its head and kicking its food into its mouth." The attachment of the head finds a parallel in the genus *Sida* (see beyond), which contains animals that can attach themselves at will to bodies by a sucker-like disk on the head, corresponding to the pedicle of the barnacles. As the barnacles and epizoa have not been observed no further mention will be made of them in this connection.

The following table from Huxley's Anatomy of Invertebrates will perhaps be useful for reference.

(Articulates or)

ARTHROPODA.

I.

Without manducatory appendages *(Gnathites)*

Trilobata. Tardigrada (?) Pentastomida(?)

II.

With pediform gnathites.

Merostomata. Arachnida. Peripatidea.

III.

With maxilliform gnathites.

Water-breathers.	Air-breathers.
Entomostraca.	Myriapoda.
Malacostraca.	Insecta.

For the most part.

The extent of the *Entomostraca* has been outlined above, and the *Malacostraca* includes the remainder of the crustaceans, viz: those included by Dana under *Podophthalmia* and the order *Choristopoda* of *Edriophthalmia*, thus embracing crabs, shrimps and all the higher crustaceans, whose body consists (almost always) of twenty segments (somnites) of which six constitute the head, and bear, respectively, the eyes, superior antennæ, inferior antennæ, mandibles, and two pair of maxillæ. Of the remaining somnites eight pertain to the thorax, and carry the foot jaws and walking limbs, while six are abdominal and bear swimming limbs. These higher forms do not go through the Nauplius stage in their development, as do the *Entomostraca*.

GENERA CHARACTERS OF ENTOMOSTRACA.

The Crustaceans of this order are quite various in form, habits and internal structure. They possess specialized jaws, but there are never more than three pairs of qualities, while in the higher orders there are often six.

The somnites of the abdomen (that portion of the body posterior to the genital aperture) are devoid of appendages. Though the study of these animals is very fascinating and instructive the task is a difficult one, both on account of the minute size of most of them and the great difficulty of ascertaining with what organs of the higher forms some of the novel instruments seen are homologous. The curious misapprehensions and inaccuracies into which authors have fallen still further complicates the matter.

The descriptions of these organs, and their functions, must be taken up under the divisions of the order and treated separately. The process of reproduction is particularly interesting in this group, for we have numerous instances of agamogenesis and the *Pectostraca* are hermaphrodites peculiarly modified Alternate generation will be spoken of more particularly under the *Daphnioidea*. The species described have all been collected and compared with descriptions of previous authors, the new species, it is hoped, will be found sufficiently well defined in connection with the figures given to permit of a ready identification.

The following table of the families of the order will be useful for reference, while the characters upon which they are founded, and synonyms, will be found in their appropriate places.

TABULAR VIEW OF ENTOMOSTRACA.

ORDER ENTOMOSTRACA.

LEGION I. LOPHYROPODA.

TRIBE I. CYCLOPOIDEA (here used as equal to *Copepoda* with the *Pœcilopoda* among he *Cormostomata* (or *Epizoa*.)

Family 1. Calanidæ.
Family 2. Cyclopidæ.
Family 3. Corycaidæ.
Epizoa?

TRIBE II. DAPHNIOIDÆ. (Cladocera.)

Family 1. Penilidæ.
Family 2. Daphnidæ.
Family 3. Bosminidæ.
Family 4. Polyphemidæ.

TRIBE III. CYPRIDÆ.

Family 1. Cypridæ.
Sub-family a. Cyprinæ. (Cypridæ Bd.)
Sub-family b. Cythrinæ. (Cythridæ Bd.)
Family 2. Halocypridæ.
Sub-family a. Cypridininæ. (Cypridinadæ Bd.)
Sub-family b. Halocyprinæ.

LEGION II. PHYLLOPODA.

TRIBE I. ARTEMIOIDEA.

Family 1. Artemiadæ. (Branchipodidæ.)
Family 2. Nebaliodæ.

TRIBE II. APODIDÆ.

Family 1. Apodidæ.

TRIBE III. LIMNADIOIDÆ.

Family 1. Limnadidæ.

Note—Other genera have been added to those given by Dana, and changes made. The family Estheriadæ seems, however, to be equivalent to Limnadidæ.

LEGION I. LOPHYROPODA.

Bibliography.—Lophyropa, *Latreille*, Cuv. Regne An., 1677;
Lophyropoda (in part), *Leach*, Dict. Sci. Nat., XIV., 554.
——— ——— *Gray*, Cat. Brit. Crust. Brit. Mus., 1850, 100.
——— ——— Baird Brit, Entomost., 138.
Cranchiopodes franges (in part), *Lamark*, Hist. Ans. Vert.

Characters.—Feet normal and not greatly multiplied in number.

TRIBE I. CYCLOPOIDEA.

Bibliography.—Carcinoida (in part), *Latreille*.
Copepodes, *Edwards*, Crust., iii., 411.
Copepoda, *Baird*, Trans. Berw. Club, ii., 1875.
——— Baird, Brit. Entomost., 182.
Cophyropoda, *Burmeister*, Organiz. of Trilobites.
Copepodita, *Gray*, Cat. Brit. Crust. Brit. Mus., 1850.
Crustacea copepoda (Cyclopacea), *Dana*, Proc. Ardes. Acad. Sci. and Art., 1847.
Cyclopoidea, *Dana*, Rep. Wilkes' Exp. Ex., p. 1020.

Characters.—Body elongate, straight, never incurved. Cephalothorax and abdomen with few joints. Feet and jaws 16 to 18. The 6–10 posterior thoracic feet are double, foliacecus, with the last often prehensile.

This is a very extensive and widely distributed division, and there is a greater unity of plan seen in the structure of the animals comprised in it than in other divisions of similar importance. These creatures are distributed over the world, in both fresh and salt water, and the numbers may doubtless be reckoned by thousands, but little attention has been devoted to the subject, and our knowledge is quite meagre.

The Cyclopoidea are considered the highest group in the order, approaching the Macroural Crustaceans. The body is not covered by a carapace, as in the following tribes, and the abdomen is extended in the same line as the body, and not incurved as in Daphnioidea, etc. The abdomen is terminated by two stylets which bear several setæ. If the Epizoa are to be admitted into this tribe, certain modifications would be necessary, which we need not discuss.

The cephalothorax is composed of from four to seven segments. In those species having four segments, the first bears the first and second antennæ, mandibles, maxillæ, maxillipods, first feet and one pair of natatorial feet, while the following three carry the remaining pairs of natatores.

Eyes of the three kinds: 1. A pair of simple internal eyes with spherical lenses, which are the ordinary kind. These are usually united near the front in a single very small spot, though they are sometimes remote.

2. A pair in an elevation on the under side of the head between the antennæ. The pigment is often like a piece of solid indigo.

3. A pair of simple eyes consisting of an internal prolate lens situated at the extremity of a vermiform mass of pigment and of a large oblate, lens-shaped cornea. This kind of eye is found in the Corycæidæ.

Antennæ. The antennæ are of two pairs, of which the superior are organs of locomotion, and usually are long and powerful. In the males of many species one or both are modified to form a joint by which the female is held during coition. These modifications are often of generic importance.

The secondary antennæ are subjected to greater changes and serve various functions. Sometimes they are simple; in other species they have two rami. They are often prehensile, and when simple the setæ at the end are movable so that they assist the animal to creep on surfaces.

The mouth is situated in the posterior aspect of a low prominence beneath the head.

The mandibles are variously modified.

The maxillæ are one to four jointed organs.

The maxillipeds are always simple, or if divided the branch is rudimentary.

Anterior pair of legs (or *second maxillipeds*). These organs vary greatly in form, and afford means of generic classification, and will be described under their appropriate heads.

Natatory feet. These are similar to those of other Entomostraca, bearing setæ for locomotion. There are four pairs, and sometimes a prehensile or abortive pair following.

The heart is situated in the posterior part of the thorax, and the circulation may be watched as the blood globules circulate between the tissues; particularly in some transparent species of Calanidæ these may be well traced in the thorax.

Nervous system. A large ganglion exists over the mouth, and surrounds the œsophagus.

This tribe includes three families, as given by Dana, but the Epizoa must probably be included also. The family *Corycæidæ* is oceanic, and no members have been found in our locality.

FAMILY I. Calanidæ.

Bibliography.—Dana, Wilkes' Explor. Ex,. p. 1039.

Characters.—Eyes often of two kinds, the upper pair being simple and minute, with their pigments either separate or collected into one. In

some species there is another pair beneath, with joined pigments. Mandibles and maxillæ elongate, carrying a palpus, which is furnished with setæ. Ova sac one. First pair of antennæ long, unappendaged; the right or neither having a geniculating joint. Feet of the first pair never sub-prehensile at the end.

The Calanidæ are divided into three sub-families, only one of which has been found to be represented in our locality, however, the classification will be indicated.

SUB-FAMILY 1. CALANINÆ.—Abdomen of moderate length, inferior pair of eyes wanting. Right superior antennæ of male without a geniculating joint. Secondary antennæ setigerous at the end.

Genus 1. Calanus, *Leach*; *Dana*.
Genus 2. Rhincalanus, *Dana*.
Genus 3. Cetochilus, *Goodsir*.
Genus 4. Euchæta, *Philippi*.
Genus 5. Undina, *Dana*.

SUB-FAMILY 2. OITHONINÆ.—Abdomen linear produced, scarcely shorter than the cephalothorax. Inferior eyes wanting. Maxille digitate on the interior margin. Superior antennæ long, few-jointed; right male antenna not geniculate nor movable in an angle.

SUB-FAMILY 3. PONTELLINÆ.—Abdomen of moderate length. Eyes sometimes of two kinds. Antennæ long and, in all the genera but *Acartia*, having a geniculating joint. Second antennæ setæ-bearing at the end. Posterior feet of the male thick; the right prehensile.

Genus 1. Diaptomus, *Westwood*.
Genus 2. Hemicalanus, *Dana*.
Genus 3. Candace, *Dana*.
Genus 4. Acartia, *Dana*.
Genus 5. Pontella, (*Pontia*, *Edwards*).
Genus 6. Catopia. *Dana*,

Genus Diaptomus, Westwood.

Bibliography.—Monoculus, *Linnæus*, *Fabricius Jurine*, etc.
Cyclops, Muller, *Desmarest*, *Manuel*, etc.
Diaptomus, *J. O. Westwood*, Partington's Cycl. Nat. Hist., Entomologist's Text-book, 1838.
——— *W. Baird*, Brit. Entomost., p. 219.
——— *J. D. Dana*, Rep. Wilkes' Expl. Ex., p. 1045.
Cyclopsina, *M. Edwards*, 1840.
——— *Philippi*, 1843.
——— *Baird*, Zoologist, i. 56: Trans. Berw. Clarb.
——— *Dana*, Proc. Amer. Acad. Art and Sci.
Omethina, *Templeton*, Trans. Ent. Soc., ii., 118, 1838.
Broteas, *Loren*,' Kongl. ret. Akad. Handl., 1845, p. 436.

Characters.—The smaller ramus of the secondary antennæ six to seven jointed. Maxillipeds scarcely less, often larger than the first pair of feet. Posterior pair of feet in the male thick, the right prehensile, those of the female long and different from the preceding pairs. Ova sac one.

Of the two species here described, one is certainly a member of this genus, while the other is in many respects more like Dana's genus *Hemicalanus*, which differs from *Diaptomus* in not having the posterior feet of the female large and stout and the shorter branch of the secondary antennæ without the numerous joints. The species of *Hemicalanus* are also oceanic. and none were seen to have ova sacs. Both our species have single ova sacs, while one is not evidently furnished with the plurality of articulations to second antennæ. Not having given a full account of the family, it may be well to incorporate a more general with the technical description. These animals are usually small, seldom reaching one-fourth of an inch, but commonly appearing as mere specks in the water. The body is canoe-shaped, and divided into two portions. The main portion, or cephalothorax, is usually much the longest. The antennæ are the organs of locomotion, being used as oars in the same manner as the "water-boatman," etc., use the feet. The posterior pair of feet vary with the sexes, as described above, the four following pairs are swimming organs, while the anterior pair are modified and turned forward.

The cephalothorax is more often seven jointed in *Pontellinæ* than in the *Calaninæ* but this is not a constant character.

Diaptomus longicornis, Herrick.*

This speccies is very near to *D. castor* and may, indeed, be a variety of that species, it differs, however, in shape and color from figures of that species, and the maxillæ, and antennæ differ considerably. Cephalothorax rather long, narrowly oval, six-jointed; superior antennæ, rather long but they are not curved as represented in Dr. Baird's figures of *D. castor*. The male right antenna has a geniculating joint at the thirteenth segment which is armed with a considerable curved spine; the joints following are more or less enlarged and sometimes coalesce, forming in extreme cases a monstrosity as represented in Geol. and Nat. Hist. Rep. for 1876. The secondary antennæ are two branched, the outer ramus being three-jointed and armed at the extremity with three curved spines, forming a sort of hand, the middle segment also bears a number of setæ on the inner margin, the minor ramus is six or seven-jointed, though it appears three-jointed at first, the middle segment being sub-divided. The head is produced into a beak in front but it is much smaller than in the following.

The maxillepedes (or first pair of feet) are of three portions, the latter two bearing setæ which are directed towards the head, the final division is composed of about six small joints each bearing a tuft of the sete. The remaining pairs of feet are alike, each having two setigiferous rami. In the female the fifth pair of feet are prehensile and stout, those of the male are unlike, the right being long and the other rudimentary.

This species is very brilliantly colored, the tips of the antennæ and last segments of the abdomen are a fine bluish purple, while the body is variegated with red, yellow and purple. The mass of eggs is also a beautiful red. Only one locality is known to contain the creature, though it may be abundant in the more marshy pools. In the Rep. of the Geol. Surv. of Minn. for 1878 it was mentioned and a figure given, but erroneously called cyclops. (See plate I.)

*See D. sanguineus, *Forbes* in Ill. State Mus. Rep. 1876. The description differs, apparently, in several respects, notably as to color, but the species is certainly closely allied.

Diaptomus pallidus, Herrick.

A more abundant form than the above, though less striking in appearance, is the creature for which this name is suggested. The cephalothorax is more elongate and has but five segments. The antennæ are much longer, considerably exceeding the body in some specimens. The joints of the antennæ following the geniculating joint are not united or modified, neither is there an appendage to the segment immediately preceding. The whole body is slender and graceful, resembling *Hemicalanus* but the fifth pair of feet is not obsolescent. The secondary antennæ were not noticed to have the multiplied intermediate oints in the minor ramus, but such may be the case.

This animal abounds in the larger lakes, and seems to prefer pure water, while the other is found in more stagnan twater. These creatures are not found infested by bell animalcules and desmids as is the cyclops, probably from their rapid motions and the nature of their haunts.

D. pallidus may be at once distinguished from *longicornis* by its lacking the brilliant coloring of the other, it being quite colorless, and by its smaller size.

D. longicornis is 65-1000 inch in length, while the species in question rarely exceeds 40-1000 inch. The eye in this species is also less conspicuous. (See plate II.)

FAMILY II. **Cyclopidæ.**

Bibliography.—Dana, Rep. Wilkes' Exp. Ex., Vol. XIV. Part 2, p. 1039.

Characters.—Eyes small, simple, usually with united pigments. Mandibles with a small or obsolete palpus and few setæ. Ova sacs one or two. Primary antennæ, often appendaged. Both or neither of the male antennæ geniculate. Feet of the first pair more or less prehensile at the end.

The prehensile character of the first pair of legs is chosen by Dana as the chief characteristic of the family; these organs sometimes being perfectly prehensile, with a perfect monodactyle hand, which never occurs in Calanidæ. These animals often possess appendages to the first and second segments of the abdomen, as see plate of *Canthocamptus.*

The cephalothorax has little variation in structure, having either four or five segments. The anterior antennæ are more often much shorter than the body, and if either of them is modified in the male, both of them have a geniculating point. The abdomen is five or six jointed, and may or not be abruptly smaller than the cephalothorax, which fact forms a basis for generic distinction.

The genus Cyclops possesses two ova sacs, while the remaining genera, so far as known, have but one. This leads to the division of the family into the two leading sub-families. The third sub-family is founded by Dana upon some sapphirina-like species of doubtful affinities, described by H. D. S. Goodsir.

Sub-family 1 Cyclopinæ, Dana.

Characters.—Ova sacs two.

Genus 1. Cyclops, *Muller.*

? Genus 2. Cyclopina, *Claus**

*There are a considerable number of genera of the following sub-families, etc., mentioned in Claus' "Zoologie", which are, for the most part, not described. Since I have not been able to consult the works in which they are defined, and since he seems not to recognize many of those described by Dana, and to disregard his classification, the deciphering of their relation and situation will not be attempted here.

? Genus 3. Psammathi, *Philippi*, Archiv. fur Naturgeschicte.
? Genus 4. Idomene, *Philippi*, " " "
? Genus 5. Euryte, *Philippi*, " " "

GENUS 1. Cyclops.

Bibliography.—(See Cyclops quadricornis.)

Characters.—Cephalothorax four-jointed. Anterior antennæ of the female not appendaged; of the male both geniculate. Appendage at the base of abdomen small. Body sub-cylindrical. Feet of the first pair didactyle.

The various species of this genus are found in inland waters the world over, being essentially fresh water animals, in a few cases only inhabiting water a little brackish. They are among the most abundant of all the individuals of the order, every standing pool abounding in them; they are also extremely variable both in different stages of the same animal, in the different sexes and in different localities.

The young stages of Cyclops have been named as distinct species, in so far that the same animal has been honored with three or four different titles between birth and maturity. In our own locality many forms have been found, and it is quite likely that careful study would enable us to distinguish several species and numerous varieties, but such is the extreme variability of the one known to exist here, that it is not now possible to draw a dividing line between the varying forms, so that all that is attempted is to give a general view of the species, and leave further definition for more minute investigation.

Cyclops quadricornis, Muller.

Bibliography.—Monoculus quadricornis, *Linnæus, Gmelin, Scopoli, Fabricins, Jurine, Sulzer, Donovan, Blumenbach, Manuel, Barbut, Shaw.*
Monoculus apus, *Poda.*
Le Monocle à querie fourchue. *Geoffroy.*
Le Monocle à quatre cornes. *De Geer.*
Cyclops quadricornis, *Muller*, Zool. Dan. Prod., 2416, 1776.
———— *Ramdhor, Latreille, Box, Lamarck, Baird, Leach, Koch.*
———— *Baird*, Brit. Entomost, p. 198.
Cyclops Geoffroyi, *Lamouelle*, British Insects, 81.
Cyclops vulgaris, *Desmarest, M. Edwards, Leach.*
———— *Baird*, Trans. Berw. Club, i., 97, (young).
———— *Garner*, Nat. Hist., Staffordshire.
Pediculus aquaticus, *Baker*, Empl. for Micros., 383.
Satyr, *Baker.*
Nauplius saltatorius, *Muller*, Zool. Prod., No. 2378.
Four-horned Cyclops, *Prichard*, Microscop. Cab.
Cyclops quadricornis of most recent writers.

The full grown female is often of considerable size, attaining the length of .09 in. or more. The male is smaller, and there is every possible gradation between the above and small forms scarcely perceptible to the unassisted eye.

The cephalothorax is usually regularly oval, but varies from short oval to oblong, it is composed of four segments, of which the anterior one is largest,

equaling or exceeding the remaining three. The superior antennæ vary in length and form. Their shape is that of a letter s. In the male both antennæ possess the hinge, or geniculating joint, which serves as a hand for retaining the female during copulation. The antennæ are about twenty-six jointed, and furnished with numerous setæ. The secondary antennæ are four-jointed, and have six setæ at the end, serving as organs of prehension.

The mandibles are ovoid bodies, terminating in short teeth, and carrying a sort of palpus of two filaments.

The maxillipeds are somewhat similar but are furnished with two toothed processes.

The first pair of feet are organs of prehension, having two rami, of which the smaller, a three-jointed organ, springs from the base of the outer or main branch.

The basal joint of the outer ramus besides bearing the other has two projections on the inner side, the second joint is hook-shaped, as is the final and smallest segment which springs from it. The four following pairs of feet are composed of two rami, each consisting of three setæ-bearing joints, as see plate of Cyclops. There is also a pair of appendages at the base of the first segment of the abdomen. The abdomen is six-jointed, the final joint somewhat bifid, each side terminating in a caudal stylet between which is located the anus.

These stylets give rise to two small setæ on the outer margin and four at the extremity. The inner pair of filaments are usually much the longest, and are also different from the others in having a joint near the base which gives greater freedom to their motions. The setæ are usually barbed backward, and in old individuals are most beautifully pectinate. In cases where the moulting has been arrested these and the other hairs attain a curiously long growth, as illustrated in the plate, and the barblets become filiform appendages.

The digestive canal begins near the front of the thorax and can be traced to the anus. The ovaries are two, and are easily seen in the body, and communicate with external ova sacs. After the eggs are extruded from the ovary into the pouches they are not dependent on the mother, but will come to maturity if separated from her. These eggs vary in number, old individuals laying upwards of forty. It is calculated that in one year a single female would have become the projenitor of 4,442,189,120 young so that the abundance in which they occur, notwithstanding the ravages of the Hydræ, and other enemies, is not strange. A single copulation fertilizes the female for life, as in the case of the Aphides. The eggs, as they are hatched, descend from the ovary covered by a transparent pellicle in which they remain from two to ten days. The growth of the young is illustrated in the plate, the operation occupying about twenty or thirty days. The cyclops moults a number to times during its life, and has the power of replacing lost parts, they are also very tenacious of life, often reviving after being frozen for a long time in the mud and water, which form their hiding places.

The cyclops is probably both carniverous and a vegetable feeder.

Plate III. represents the usual form, the figures showing the different stages are copied from Dr. Baird's Entomostraca. *Plate IV.* gives one of the varieties collected here which may be worthy of a specific name; the greatly exaggerated caudal filaments and general hairiness is, however, only an age-modification, the color of this variety is dark, while the eggs in the sacs are pellucid. Another variety is oblong in shape and lighter in color, while the egg sacs are opaque. Still other varieties are smaller, and vary from bright red to green in color, having the egg sacs diverging from the abdomen. There seem to be intermediate forms and it is best to await further study before separating these varieties. (See Plates III. and IV.)

SUB-FAMILY 2. HARPACTICINÆ.

Characters.—External ovary only one.

* Cephalothorax 4-jointed.

Genus 1. Canthocamptus, *Westwood.*
Genus 2. Harpacticus, *Edwards.*
Genus 3. Westweodia, *Dana.*
Genus 4. Alteutha, *Baird.*
Genus 5. Metis, *Philippi.*
Genus 6. Clytemnestra, *Dana.*
Genus 7. Setella, *Dana.*

** Cephalothorax 5-jointed.

Genus 8. Laophon, *Philippi.*
Genus 9. Oncæa, *Philippi.*
Genus 10. *Ænippe, Philippi.*
Genus 11. Idya, *Philippi.*

Genus 1. Canthocamptus.

Bibliography.—Monoculus, *Linnæus, Fabricius, Jurine*, etc.
Cyclops, *Muller, Ramdohr, Latreille*, etc.
Cyclopsina (part), *M. Edwards.*
Canthocamptus, *Westwood*, Partington's Cyclop. Nat. Hist. art. Cyclops; Entomologist's text-book, 115.
Canthocarpus, *Baird*, Trans. Berw. Nat. Club.
Harpacticus (part) *Dana*, Proc. Amer. Acad. Arts and Sci., 1847.
Nauphilius, *Philippi*, Ann. Mag. Nat. Hist., 1840; Wiegm. Archer, 1843.

Characters.—Body scarcely flattened, generally linear or narrow. Feet of the first pair (second jaw feet of Baird) more often small; those of the second pair with two rami, rami three jointed. Antennæ of the female with an appendage at the end of the fourth joint, those of the male both with a geniculating joint. Appendix to base of the abdomen small. Generally no sudden transition from the segments of the thorax to those of the abdomen.

Canthocamptus minutus. *Bd.*

Bibliography.—Cyclops minutus, *Muller*, Zool. Dan. Prod., No. 2409, 1776; Entomostraca, 101, t. 17, f. 1–7.
———— *Ramdohr*, Beyt, zur Naturg., 10–13, t. 3, f. 1–9.
———— *Latreille*, Hist. Nat. Crust., IV. 266.
———— *Bosc*, Mém. Hist. Nat. Crust., ii. 257.
———— *Lamarck*, Hist. Aus. Vert., V. 189.
———— *Baird*, Trans. Berw. Nat. Club, i. 97, 62, f. 1,19,20, etc.
Monoculus. *Gmelin*, Linn. Sgot. Nat. Edit. 13th, i. 2997, No. 11.
———— *Fabricius*, Ent. Syst., ii. 499, No. 45.
———— *Manuel*, Encyc. mith., vii., 719, t. 267.
Monoculus staphylinus, *Jurine*, Hist. Nat. Monoc., 74–84.
Cyclops —— *Desmarest*, Cons. Gen. Crust. 363, t. 53.
———— *Baird*, Trans. Berw. Nat. Club, i. 97.

Small Cyclops or Vaulter, *Prichard*, Mec. Cab., t. 9, f. 7.
Amyone satyra and Baecha, *Muller*, Entomost., 42 t. 2 (young).
Der Satyr, *Kohlers*.
——— *Prichard*.
Cyclopsina staphylinus, *M. Edwards*, Hist. Nat. Crust., iii. 428.
Canthocarpus ——— *Baird*, Trans Bew. Club, ii., 154.
Nauphilius minutus, *Philippi*, Weigm. and Erichs, Ar. 1843, 69.
Doris minuta, *Koch*, Deutsch, Crust., li. XXXV. t. 3, 1841.

Variety occidentalis. Herrick.*

Description, etc.—This variety, which is the only member of the sub-family yet distinguished in our locality, is so closely related to the type of the species as described by Dr. Baird that it is with much hesitation that it was finally concluded to separate it. The description given will apply to both, with such exceptions as will be pointed out..

Body rather long with no obvious distinction between the segments of thorax and abdomen, composed of ten segments, which taper toward the tail. Cephalothorax acute in front, resembling that of species of *Calanus* (in which respect it differs from Dr. Baird's figures of the European species) forming a sort of beak below. Viewed from the side the shape is triangular. The primary antennæ are shorter than in Cyclops, and those of the males more altered than is usually the case in that genus. In the male they consist of seven joints, the fourth of which is much enlarged.

The antennæ of the female possess eight or nine joints. and have a small projecting appendage from the extremity of the fourth segment. The secondary antennæ are simple with two or three joints.

The eye is bright red and contrasts finely with the pale yellow of the body. The mandibles are similar to those of the cyclops. The maxillipeds are divided at the end into four divisions at the extremity of which spring three or four setæ.

The first pair of feet (or second foot-jaws of Baird) are small, three-jointed organs. The final joint is hook-like, and directed forward for the purpose of arresting food particles and carrying them to the mouth.

The second pair of feet are large and modified in form, differing from the natatorial feet, (they form the basis of classification in this whole sub-family). Each is composed of two three-jointed rami, of which the outer one has the joints nearly equal with three setæ. At the apex of the final one, the inner ramus has the upper joint long, almost equalling the outer ramus. The second joint is shorter and with the final one, which carries at the extremity three long setæ, is serrated on the anterior margin. This ramus is directed forward also. The three following pairs have the rami unequal but both with three joints.

The sexual openings are at the base of the sixth segment. In copulation the males seize the caudal stylets with the geniculating joint of the primary antennæ and are bourn about rapidly by the female.

In most of the females seen there was a organ attached to the vulva, it consists of a long flexible stalk terminated by a cylindrical or club-shaped mass, which may be dark brown, red or pellucid.

*S. A. Forbes describes a species in Report Ill. Mus. Nat. Hist., the characters of which I have not been able to compare with our specimens, but it seems distinct.

It was conjectured by M. Siebold that these were similar to the seminal tubes discovered by him upon Diaptomus. The act of copulation in Diaptomus, as described by him, is so strange and improbable that it is hard to accept without some hesitation. He says that "the male does not accomplish a true coition but attaches to the female, during copulation, a tube containing spermatic liquor. This tube contains, beside the zoosperms, two substances of which one swells by the influence of water, and chases out the whole contents of the tube. The other substance coagulates, leaving in the middle of the mass a canal by which the zoosperms arrive at the vulva."

In the case of the Canthrocamptus, however, the appendage is apparently of a different nature, being corneous and harder than the rest of the animal, moreover in no case have more than one of these been observed on the same female. Jurine, however, says that this body is never seen till after she has several times laid eggs. Dr. Baird adds that he has never seen more than one on the same female, and that no mature female is met without it, even though the ova are attached. My own observations accord with the above, but I am unable to add any suggestion as to the use of these organs.

The females are larger and usually darker in color than the male.

Habitat.—Shallow lakes and pools; everywhere abundant.

This species will repay well patient study, and from its abundance is easily found. This western variety is distinguished from the eastern type by the shape of the head, the greater brevity of the caudal stylets. the shape of the ova sac, the greater size of the fourth joint of the male antennæ, and other minor differences, which no great stress is laid upon, however; and these variations may be due to inaccuracies of the drawings of Baird's book. (See plate V.)

Sub-family 3. Steropinæ, Dana.

Characters.—Form somewhat like Sapphirina, but the eyes minute, and generally situated in a prominence in the front. Superior antennæ short. Feet of the first pair monodactyl as in Corycæcidæ. Caudal stylets short, sub-cylindrical.

Genus 1. Zaus, *Goodsir.*

Genus 2. Sterope, *Goodsir.*

No member of the family was met with.

FAMILY III. CORYCÆIDÆ.

The species are all oceanic. A species of Sapphirina is figured in the Rep. of Fish and Fisheries for 1871 and 1872.

TRIBE II. DAPHNIOIDEA. Dana.

Bibliography.—Daphnioidea, *Dana*, Rep. Wilkes' Expl. Ex., p. 1262.
Cladocera, *Baird*, Brit. Entomost. p. 62, 1850.
——— *Burmeister*, But. zur Naberg. Der Rankenfuss.
Daphnides, *Straus.* Mem. Mus. d'Hist. Nat.
Daphnoides on Cladocères, *M. Edwards*, Hist. Nat. Brust., iii. 372.
——— *Lucas*, Exp. Sc. de l'Algine.

Characters.—This tribe which corresponds with the *order Cladocera* of Baird and some recent authors, is characterised as having the whole

body, exclusive of the head, (which is covered with a separate and similar plate) included in a large carapace, which is open below and behind, permitting the protrusion of the posterior portion of the abdomen, and allowing currents of water to pass within, both for respiratory purposes and to carry to the mouth particles of food.

The carapace is composed of three parts, in one species at least, and it would seem that this is the typical structure. The middle plate (in Daphnia vetula) lies over the dorsal region; the other two spring from it, flanking it on either side, and forming the bulk of the shield. We would suggest the probable similarity of the central shield to the caudal shield of other crustaceans, and the possibility that the now larger portions ought really to be considered as accessory simply.

The Daphinoidea possess from four to six pairs of foliaceous appendages, or branchial feet which do not assist in locomotion. The eye is apparently single and is a very prominent organ in all the members of the tribe, it is large and furnished with numerous lenses.

The superior antennæ are small, often obsolete, and except in Bosmina only one or two-jointed. The inferior antennæ are large, being the true organs of locomotion, and several-jointed.

The abdomen is incurved, mobile, furcate at the extremity and bears two prominences on the dorsal angle which are the origin of setæ.

The carapace is often beautifully reticulated and sometimes there are more than one sort or series of these markings. The Daphinoide are distinguished from Cyproidea by the presence of posterior foliaceous legs, which is considered by Dana as of greater importance than the more obvious peculiarity—the exclusion of the head from the carpace.

Prof. Dana has united the genera of Dr. Baird's *Daphniadæ*, *Polyphemidæ* and *Lynceidæ* in this tribe, and this seems appropriate, since there cannot certainly be as wide a gap between *Daphnia* and *Lynceus* as between the curious *Bosmina* and *Daphnia*, yet the latter two were united in one family and Lyncens separated as totally distinct. The chief peculiarities which lead to the separation of Lynceidæ were first, the fact that they possessed in front of the eye a "black spot" of unknown use, and second, that the head was produced in front to form a more or less prominent beak.

But it has since been ascertained that the black spot is a common feature among the species of the whole tribe and, according to modern authors, is in someway connected with the base of the superior antennæ and serves, probably, as an organ of hearing.

The characters of the head seem to have been misunderstood. In all the species of the Daphinoidea which I have examined, the head seems to be covered with a curved plate or carapace, within which is the insertion of the organs of the head. Now a little change of position under the microscope serves to give to the anterior portion of this covering on acute or obtuse appearance, depending on which side of the carapace is in the focus of the instrument. As the shape of the beak is used as a generic character in this sub-division it seems quite probable that the matter will need further revision. The fact that the intestine is or is not convoluted was shown by Dana to be of no generic importance.

The characteristics of the tribe may be best seen as illustrated in the subdivisions.

FAMILY 1. PENILIDÆ. Dana.

Bibliography.—Penilidæ, *Dana*. Pro. Amer. Acad. Sci., ii., 47, 1849.
Sidina, *Baird*, Brit. Entomost, 106.
Sididæ, *Gray*, Cat. Brit. Crust. Brit. Mus., 93, 1850.

Characters.—Foliaceous feet twelve, narrow. Anterior antennæ obsolescent.

Genus 1. Sida, *Straus*. Posterior antennæ with the longer ramus three-articulate, shorter, two-articulate. Head not beaked below.

Genus 2. Daphnella, *Baird*. Both rami of posterior antennæ two-jointed. Anterior antennæ borne by the middle of the under aspect of the head.

Genus 3. Penilia, *Dana*. Both rami of the posterior antennæ two-jointed. Head short, produced below. Primary antennæ borne on the extremity. Species marine.

? Genus 4. Latona, *Strauss*. Posterior antennæ having three one-articulate rami.

Only one species of this family has been met with, which is here described.

Genus 1.

Sida, (*Straus.*)

Bibliography.—Sida, *Straus*, Minn. Mus. Hist. Nat., v.
—— *M. Edwards.*
—— *Baird.*
—— *Dana.*
Daphnia, *Mulller.*
——— Latreille, etc.
Monoculus, *De Geer.*
——— *Jurine, etc.*

Generic Characters.—Superior antennæ of moderate size. Longer rami of inferior antennæ with three articulations, shorter rami with two. Inferior antennæ very large and powerful.

Sida crystallina, *Muller.*

Bibliography.—Daphne crystallina, *Muller*, Zool. Dan. Prod., No. 2,405, 1,776.
Daphnia crystallina, *Muller*, Entomost., 96, t. 14, f. 1–4.
——— ——— *Latreille*, Hist. Nat. Crust. IV., 230.
——— ——— *Rosc*, Minn. d'Hist. Nat. Crust. II., 281.
Sida crystallina, *Straus*, Minn. Mus. Hist. Nat., V.
Sida crystallina, *M. Edwards*, Hist. Nat. Crust., III., 383.
Monoculus crystallina, *Gmelin*, Linn. Lyst. Nat., edit. 13th, I. 3,000, No. 29.
——— ——— *Manuel*, Enc. Mith., VII. 724, t. 265, f. 15–18.
——— ——— *Fabricius*, Ent. Syst., II. 493.
Monoculus elongatus, *De Geer*, Mem. Servis Hist. Ins., VII. 470, t. 29, f. 1–4, 1,778.

Description, etc.—General shape that of an elongate rectangular prism, or sub-cylindrical. Carapace elongate oval, truncate before and behind, very transparent, being obviously reticulated only near the anterior portion.

Head large, obtuse in both vertical and horizontal aspect, furnished with a projecting disc or plate on the posterior part of upper surface. Eye round and rather large, red, with many corneæ.

Superior antennæ are quite observable, being rather long and armed with four bristles on the extremity.

Inferior antennæ very large. The basal joint is cylindrical, very large and fleshy, and wrinkled so as to appear many jointed. The two rami are unequal and rather short. The outer ramus has three articulations. The first is short and furnished with a minute spine. The second is longer and has three strong-jointed setæ on the inner margin, and a spine near its articulation with the third, which is of nearly the same length, and has four setæ on the inner margin, three at the end and a small spine at the upper outer angle.

The inner ramus has two unequal joints, the lower of which is much the longer, and is furnished with a spine and a seta, while the second has four large-jointed setæ at the extremity.

The labrum and mandible are similar to those of Daphnia.

The feet are of six pairs, which are described as follows:

The first pair consists of a main stalk of two joints, of which the first has four setæ, and the terminal (or "hand") joint seven. The first joint also has two branchial plates, of which the upper and smaller possesses nine or ten short setæ and one jointed and plumose filament, while the lower or main plate has about thirty plumose setæ. The second, third, fourth and fifth pairs are quite similar, but the stout setæ on the outer margin of the first joint are replaced by a triangular plate and the branchial filaments are shorter. The sixth pair has three articulations, each furnished with straight, stout spines, and is curved. The abdomen has at its extremity two strong, curved claws, which have each three spines on the basal half, and are dentate for the remainder of their length; it also has two tubercles at the angle behind each of which bears a long seta. Between the claws and these knobs are two rows of spines.

The ovary contains in full grown females, about twenty young, which resemble their parent from birth.

The organ on the top of the head is used as a sort of sucker, by which the animal adheres to water plants.

Their motion is rapid and steady. The circulation of the blood can be seen through the transparent walls of the body and head, as in the front part of the head, where the minute, colorless corpuscles are easily seen coursing from above. There appears to be a dorsal vessel just above the intestine in which these globules can be seen as they pass from behind forwards to near the juncture of the carapace with the glabella of the head, where is an enlargement forming the heart, the pulsations of which are uniform with the motions of the branchial feet. The motion of the feet, besides the aeration of the blood, propels (as in others of this family) a strong current of water between the bases of the limbs toward the mouth, bringing to it the particles on which it feeds and which it has no other means of capturing.

This interesting creature is quite rarely seen, whether from its reclusive habits or actual scarcity I do not know, but it deserves the attention of students, as presenting, both on account of its size and transparency and its somewhat anomalous structure, one of the best opportunities of investigating these little known forms.

Habitat.—"Grassy Lake," a pond tributary during high water to Lake Calhoun, near Minneapolis; also Diamond Lake. The animal seems to be found in lakes not completely isolated, and does not prefer so muddy a situation as most of the Daphnioidea.

The structure of this animal was compared minutely with the description given by Dr. Baird of *S. Crystallina*, and is beyond doubt identical. *Plates VI and VII.*

FAMILY II. DAPHNIDÆ.

Bibliography.—Daphnidæ, *Dana*, Rep. Wilkes' Expl. Exp., p. 1265.
———— *Dana*, Proc. Amer. Acad. Sci., ii., 1849.
Daphnita, *Gray*, Cat. Brit. Crust. Brit. Mus., 88.
Daphniadæ, (part), *Baird*, Brit. Entomos. 62.

Characters.—Foliaceous feet ten. Anterior antennæ one or two-jointed.

1. Head large.

Genus 1. Daphnia, *Muller*, (including Ceriodaphnia of Dana, which differ in the shape of the reticulations of the shell.)

Genus 2. Moina, *Baird.*

Genus 3. Macrothrix, *Baird* (including Acanthocerus of Schodler.)

2. Head short.

Genus 4. Lynceus, *Muller* (including *Eurycercus*, *Chydorus*, *Peracantha*, *Pleuroxis*, *Acroperus*, *Campotercus* and *Alona* of different authors, until some valid generic characters are announced.)

Genus Daphnia, Muller.

Bibliography.—Daphnia, *Muller*, Zool. Dan. Prod.
———— *Muller*, Entomost.
———— *Straus*, *Desmarest*, *Latreille*, etc.
Monoculus, *Linnæus*, *Poda*, *Blumenbach*, *De Geer*, etc.

The Daphniæ are among our most abundant and most interesting Entomostraca, occurring in stagnant water everywhere, they are very prolific and voracious. This genus is confined strictly to fresh water.

The general characters will be gathered from the description of the tribe and of the species. The superior antennæ are usually rudimentary and hidden, but vary with the sexes. The most prominent organs are the inferior antennæ, which are large and powerful. They consist at the base of a single large, fleshy joint which has all possible play upon its attachments. This joint supports two branches of nearly equal length, but the outer is usually four-jointed, while the inner has but three articulations. Each of the last three is furnished with a long seta which is jointed at the middle, and usually pecinate, forming a fine swimming organ. The eye is a large, conspicuous organ near the front and is so furnished with muscles that it has a semi-rotation. This organ occupies a prominence on the underside of the head, which projects backward supporting the minute antennæ and the black spot before noticed. Baird says that the eye was mistaken by one author for the *stomach*. The chief gangilon of the nervous system lies near and communicates with the eye. The mouth lies at the back of the prominence described, and is armed with a labrum, a pair of mandibles and a pair of jaws. For particulars of structure see plate IX.

The digestive system is the most conspicuous part of the creature when filled. It is then often of a brillant green color, extending along the whole dorsal region. The œsophagus is short, opening into the stomach just behind the brain gangilon. From this point the stomach curves upward and extends thence through the whole length of the animal. The contractile vessicle above the stomach is quite an obvious feature, but Gruithuisen says there are two hearts, one venous, the other arterial, but this is probably not established, though the existence of a dorsal vessel above the stomach is probable from analogy and observed appearances.

The legs, which are of five pairs, vary considerably, but the same plan is preserved. At the base of each is a branchial plate furnished with fine branchial filaments corresponding to gills, while the remaining portions of the leg serve to create currents of water toward the mouth. The result is a vigorous current between the legs under the body, which transports the food particles to the maxillæ. The ovaries are along the sides of the abdomen, and the ova are normally hatched within the shell of the parent above the abdomen.

These creatures have been supposed hermaphroditic, from the extreme scarcity of the males, but they are in this respect like the Aphides, being parthenogenetic. Besides the ova which are hatched within the shell of the living parent, another method is seen. The outside of the carapace grows opaque, and finally two spots appear within which are the eggs. When the moult takes place, the carapace with its burden is left in the water until a favorable time, when the eggs hatch. This obviously is a protection against the cold of winter, for the ephippium, as the carapace thus loaded is called, is thick and horny. The ephippia may be observed in winter, floating about in the water, often in abundance. (See plate IX.)

Daphnia Pulex.

Bibliography.—Monoculus pulex, *Linnæus*, Sys. Nat. 10 Ed., i., 635, No. 4, 1758.
——— *Gmelin*, Syst. Nat. 13th Edit., i., 2999, No. 4.
——— *Poda*, Ins. Mus. Græcus, 124.
——— *Muller*, Faun. Insect. Fredrichsdalens, 95.
——— *Blumenbach*, Handbuch der Naturg., 399.
——— *Manuel*, Enc. nieth., VII., 722, No. 15, t. 265, f. 1–4.
——— *Fabricius*, Entoml. Syst., ii., 497.
——— *Leach*, Encyc. Brit. art. Entoml.
——— *Jurine*, Hist. des Monoc., 85.
——— *Cuvier*, Tab. Element., 455.
Daphene pulex, *Muller*, Zool. Dan. Prod., 199, No. 2400, 1776.
Daphnia pulex, *Latreille*, Gen. Crust. et Ins.; Hist. Nat. gen. et part., des Crust; Règne Anim. Cuv.
——— *Lamarck*, Hist. Nat. des An. s. Vert. Edit. 2, V., 181, No. 1.
——— *Lamouelle*, British Insects, 81.
——— *Straus*, Mem. der Mus. d'Hist. Nat., v. t. 29.
——— *Demarest*, Consid. gén. sur les Crust., 372, t. 54.
——— *Baird*, Ann. Nat. Hist., i., 254.
——— *M. Edwards*, Hist. Nat. des Crust.
——— *Guerin*, Iconograph. Crust., t. 33.
Daphnia pulex, *O. Fabricius* Faun. Grœnland., 263.
——— *Leach* Edin. Encyc., vii. art. Crustaceol.

Daphnia pennata, *Muller*, Entomost., t. 12, f. 4–7.
——— *Bosc*, Man. d'Hist. Nat. des Crust., ii., 280.
——— *Schrank*, Faun. Boic., iii., 264.
Monoculus pulex arborescens, *Linn*. Syst. Nat.. 4th Edit., 96.
Pulex arborescens. *Swammerdam*, Hist. Nat. Ins. Gen., 76, t. 1, f. o. b. c. Biblia Naturæ, 86, t. 31, f. 1–3.
——— *Goeze* Naturfoscher, pt. 7.
Monoculus pulex ramosus, *De Geer*, Mém. pour servir à l'Hist. Ins., vii., 442.
Daphnia ramosa, *Koch*, Deutsch. Crust., h. XXXV., t. 18.
Daphnia media, *Koch*, Deutsch. Crust., h, XXXVII. t. 1.
Daphnia ephippiata, *Koch*, Deutsch. Crust., h. XXXV t. 16.
Puckron branchu, *Trembley*.
Water-flea with branching horns, *Baker*, Empl. for Micros.
Pou aquatique, *Joblot*, Observ. d'Hist. Nat.
Le Perroquet d'can, *Geoffroy*, Hist. abrég. Ins.
Vermes minimi rubri, *Merrett*, Pmax Res. Nat. Brit.
Ammaletti aquatici, *Redi*, Asservazioni. Opere.
Monoculus, *Bradley*, Phil. Occ. of Works of Nature.
Le Puceron verdatre, *Ledermuller*.

Var. 1. Daphnia longispina, *Muller*.
——— *Latreille*.
——— *Bosc*.
——— *Ramdohr*.
——— *Lamarck*.
——— *Straus*.
——— *Demarest*.
——— *M. Edwards*.
——— *Koch*.
Monoculus longispinus, *Fabricius*.
——— *Manuel*.
——— *De Geer*.
——— *Schæffer*.

Var. 2. Daphnia magna, *Straus*.
——— *Demarest*.
——— *M. Edwards*.

Description.—Carapax oval or sub-quadrangular, transparent, more or less reticulated on all or part of the surface. Head large, more or less beaked. Superior antennæ very small. Inferior antennæ strong and long. The superior antennæ have five small setæ at the apex, while the inferior pair are armed with the usual complement of setæ, which in this species are finely plumose.

The color of this animal, which is our commonest and one of the largest species, is dependent upon the food taken into the stomach, which extends through nearly the whole length of the body in all the species. When feeding upon clean vegetation the intestinal canal is of a brilliant green hue, while at other times it is dark or brownish. In England they are often of a bright red color throughout, but I have never met with such here.

The carapax is terminated posteriorly by a serrated spine, which is variously situated, and varies also with the age of the animal. In one variety the spine is situated at the upper posterior angle while in others it springs from the centre of the posterior aspect. In the young the spine is long, almost equaling sometimes

the carapax in length, but at each successive moulting the spine is found to be shorter. The upper part of the body has four projections, one of which is longer than the others and serves evidently to keep the ova in position.

Dr. Baird says that " the male is much smaller than the female", which is the case in nearly all the species, "and the superior antennæ are much larger and spring from under the beak instead of from the beak itself. The inferior extremities of the valves are more densely serrated than in the female."

The males are always fewer than the females. The motions of this creature are quick, spasmodic leaps through the water, and it often presents a beautiful appearance.

Daphnia Vetula.

Bibliography.—Daphne vetula, *Muller*, Zool. Dan. Prod., No. 2399.
Daphnia vetulo, *Straus*, Mém Mus. Hist. Nat., V., t. 29, f. 25–6.
———— *Baird*, Ann. Mag. Nat. Hist., i., 255, t. 9, f. 13.
Daphnia sima, *Muller*, Entomost., 91, t. 12, f. 11–12, 1785.
———— *Latreille.*
———— *Bosc.*
———— *Ramdohr.*
———— *Gruithuisen.*
———— *Desmarest.*
———— *Lamarck.*
———— *M. Edwards.*
———— *Koch.*
Monoculus sima, *Givelus.*
———— *Manuel.*
———— *Jurine.*
Monoculus lævis, *Fabricius.*
Monoculus expinosus, *De Geer.*
Monoculus conchacus, *Donovaan.*
Ungeschwauzter-zackiger, *Wasserfloh, Schæffer.*
Monoculus nasutus (?) *Jurine.*
Monoculus pulex, *Sulger.*
Daphnia congener, *Koch.*
Daphnia expinosa, *Koch.*

Description.—In size like *Daphnia pulex*, some forms of which it resembles. Carapax in the male quadrangular with the sides nearly parallel, the posterior prominence being near the dorsal part of the shell. In the female, however, the prominence is near the middle of the posterior side, while the carapax is widest near that extremity. The spine usually present in the larger Daphnidæ is obsolete, but there is a series of small spines or teeth on the upper posterior margin. The lower edge is strongly ciliated. The carapax is strongly lined transversely. These striæ arise from the one or two rows of hexagonal cells which border the lower margin, and anastomose occasionally, giving in some cases a reticulated appearance to the shell. The head is very small proportionately, rounded in in front, and rather strongly beaked below.

The superior antennæ are quite evident. Inferior antennæ large. The first joint is fleshy and stout, margined at the extremity with spines and sending out three branches, of which the two large swimming organs are as in *pulex*, having the plumose setæ, etc. At the base and between these is a third, consisting of a conical point with a broadened base ending in a spinous appendage. The scuta

of the head seems wider and less arched than in other species. Jaws long and ending in a circle of fine teeth. Feet as in *pulex*.

Seen from above the carapax of the body is found to consist of three pieces The first, which might be termed the scutella, is a small shield adjoining the head, and the two principal pieces or valves of the shell may be considered as appendages of the scutella. These pieces may be compared to the *tergum* and *pleuron* of trilobites.

The structure of the beak and its relation to the head is more clearly seen than in most of the Daphniæ. The head shield as seen from below is transversely sub-oval. Directly in front and very near the anterior margin of the skull is an eye, filling a circular elevation reaching the anterior margin, and sending off posteriorly a ridge or straight partition which divides the lower aspect of the head into two basin-like cavities. This ridge terminates in the beak which carries the superior antennæ and the black spot which Huxley calls an ocular pigment, but by other authors is thought to be attached to the auditory apparatus, and is termed by Dana the "otolites", following Schoder in so consideriug it. (See *Plates X. and XI.*)

Daphnia Mucronata.

Bibliography.—Daphne mucronata, *Muller*, Zool. Dan. Prod., No. 2404, 1776.
Dapnia mucronata, *Muller*, Entomst., 94.
——— *Desmarest*. Cons. gèn. Crust. 374.
——— *Latreille*, Hist. Nat. Crust., IV., 229.
——— *Bosc*, Man. d'Hist. Nat. Crust., ii., 281.
——— *M. Edwards*, Hist. Nat. Crust. iii., 382.
——— *Baird*, Trans. Berw. Nat. club, ii, 148.
——— Monoculus mucronatus, *Gmelin*, Linn. Syst. Nat., edit. 14th, i., 3,000, No. 28.
——— *Manuel*, Enc. Mith., t. 265, f. 19.
——— *Jurine*, Hist. Nat. Monoc. 137, t. 14, f. 1, 2.
Monoculus bispinosus, *De Geer*, Mem. Servir. Hist. Ins., VII., 463, 1778.
——— *Fabricius*, Ent. Syst., iii., 493.
Daphnia bispinosa, *Koch*, Deutsch. Crust., h. VIII., t. 1.

Description.—General shape, as seen from above, oval. Lower margin of the carapax straight, terminated posteriorly by a curved spine. Head triangular, obtuse in front. Eye large. Superior antennæ small. Inferior antennæ long. Lower part of the carapax ciliated. Color dark. Dr. Baird says that the form of the head varies in this species, being sometimes rounded and at others terminated by a sharp, somewhat curved point directed upwards.

I have not observed in any of the many specimens seen a sharply pointed head; and though this point casts some doubt on the identification, every other point in his description seems to agree very well with our species, which I find no warrant for separating from *D. mucronata* var. *obtuse rostrata*.

Habitat.—Sandy Lake (East Minneapolis), Clark's Lake, Grassy Lake, etc. (See *Plnte XII.*)

Daphnia (Ceriodaphnia, Dana) Reticulata.

Bibliography.—Monoculus reticulatus, *Jurine*, Hist. Nat. Monoc., 139, t. 14, f. 3, 4.

Daphnia reticulata, *Desmarest*, Cons. gén Crust., 374.
M. Edwards, Hist. Nat. Crust., iii., 381.
——— *Baird*, Trans. Berws. Nat. Club. ii., 148.
Daphnia ventricosa (?) *Koch*, Deutsch. Crust., h. XXXV., t. 21.
Daphnia quadrangula, *Muller*, Ent., 90, t. 13. f. 4.
——— *Latreille*, Nat. Hist. Const. IV., 227.
Monoculus quadrangula, *Gmelin*, Linn. Syst. Nat., 2999, No. 24.
Monoculus quadrangularis, *Manuel*, Enc. Mith., VII., 723, No.15.
Monoculus quadrangulus, *Fabricius*, Ent. Syst., ii., 492.

Note.—I was not able to fully satisfy myself that this is certainly identical with the species described by Baird but there are no good reasons for believing it a distinct species. It is round enough for D. *rotunda*. There is an evident spine on the posterior angle of the shell, though it sometimes is almost obsolete. The reticulations are hexagonal (?). The color in the specimens examined is greenish, and moreover the superior antennæ agree better with *reticulata* than *rotunda*. The size is small.

Description.—Small (.02 in. or over). Carapace oval and comparatively very broad, covered with hexagonal markings. Head small as compared with the body, and more nearly at right angles with it than in most of the Daphniæ. There is also a slight depression a little in front of the juncture with the body. Superior antenæ rather larger than in most Daphniæ, and somewhat movable. Inferior antennæ quite large. Beak none. Feet as in the larger species.

This species is very active on account of the length of the antennæ, which have shorter spines (not plumose) than *D. pulex*. It presents a robust appearance in swimming either on its back or face, since it is much broader in proportion than most other species.

Habitat.—Lake Amelia, Grassy Lake, etc. Not very abundant but widely distributed.

Baird says of this species: "The ephippium differs considerably from that of *pulex*. It is more rounded, white at the centre, with a large round ampulla, containing only one ovum. When the animal has the ephippium on, it possesses a square appearance, and is the *D. qaadrangula* of Muller."

This is one of the commonest species in many of our lakes, while in others it is replaced by the *pulex*, for as yet I have not seen them both in the same locality.

Habitat.—Grassy Lake, Lake Amelia, etc.

(See Plate VII.)

Daphnia spinosa, Herrick.

Description.—General shape of the Daphnia pulex; carapace armed at the upper posterior margin with a rather long, serrated spine. The first of feet are long, bristled at the extremity as in young specimens of D. pulex. The anterior antennæ are larger than in pulex and two-jointed and setæ-bearing at the end. Posterior antennæ exactly as in pulex. The eye is nearer the antennæ than in other species, but the most striking peculiarity is the pointed spine formed by the front of the head, which is very marked. Carapace not obviously reticulated, transparent.

Habitat.—Found in Lake Calhoun, but not in large numbers. It seems to inhabit the deeper waters.

(See Plate XIII., p. 1.)

GENUS **Macrothrix.**

(Sig.—long hair.)

Bibliography.—Macrothrix, *Baird*, Ann. Mag. Nat. Hist., XI, 87, 1843, and XVII, 412; Trans. Berw. Nat. Hist. club, ii, 149.
Daphnia, *M. Edwards*, Hist. Nat. Crust., iii, 384.
——— *Muller* (?) Entomost.
Lynceus, *Desmarest*, Cons. Gen. Et. Part. Crust., 376.
Monoculus, *Jurnine*, Hist. Monoc. Generc.
Acanthocercas, *Schulder* Ericks, 1846.
Macrothrix, *Dana*, Wilkes' Explos. Exp. Report.

Characters.—Head, beneath, either subacute or rather obtuse, anterior antennæ rather long, pendulous from the beak, eye accompanied by a rather large black spot at the base of the attennæ; seta from first joint of anterior branch of inferior antennæ much longer than the others.

Macrothrix agilis, Herrick.

Description.—Head shield (as seen from above) very nearly square; body carapace pear shaped; eye smaller than in *Daphnia* and accompanied with a rather large black spot similar to the obvious spot in Lynceus, but even larger. Superior antennæ very long in comparison with other members of the family. Inferior antennæ rather large, armed with large setæ, of which the spine from the end of the first joint is extremely elongate and plumose, nearly as long as the body. This joint also has a small spine on the opposite or upper side of the ramus.

The spine from the second joint is larger than in *Daphnia*. The final joint bears a small spine also in addition to the three setæ. (In the drawing both of the rami have the elongate seta. This may be a mistake in the observation, which was made in some haste.)

The jaws, feet, and posterior segments of the body, are similar, as far as observed, to like organs in *Daphnia*.

The lower and posterior part of the margin of the carapace bears a number of long stout spines directed backward. The posterior body filaments, instead of being simple or only plumose, are divided at the extremity into four small bristles, forming a tassel or brush at the end.

The intestine is not convoluted but is more abruptly curved and depressed near the head than in *Daphnia*, thus approaching *Lynceus*.

The motions of this interesting animal are lively and impetuous, it being assisted by the long filaments of the antennæ, which, with the body spines and strong teeth of the shell, give to it a spider like aspect.

This species differs materially from any described by Baird, or any other author with which I am familiar, but even if the elongate filaments should prove to be common to both rami of the antennæ, it must fall in this genus.

Habitat.—Only observed in Rocky Lake, a small pool near East Minneapolis.

Plate XIV.

GENUS **Lynceus,** Muller.

This genus was rejected by Dr. Baird who founded upon its remains a number of genera, most of which were rejected in turn by Prof. Dana, who recognized the following:

Lynceus, *Eurycercus* and *Alona*.
Lynceus—Eurycercus of Dr. Baird.
Eurycercus—Chydorus, *Percantha* and *Pleuroxus*.
Alona—Alona, *Acroperus* and *Camptocercus*.

In the genus *Alona*, he says, the beak diverges from the body at a large angle (60° to 90°) with the shell adjoining, while in *Lynceus* it is usually curved parallel to it.

But, as Dana himself admits, the distinctions are of doubtful importance, and it would seem preferable to retain Muller's old genus instituted for all of these forms than to further complicate the matter until a large amount of material shall be gathered and compared. The species observed will, therefore, be briefly described and the probable place in the rejected genera indicated.

Lynceus macrourus. Muller.

Bibliography.—Lynceus macrourus, *Muller*, Dan. Prod., 2397.
——— *Latreille*, Hist. Nat. Crust., 207.
——— *M. Edwards*, Hist. Nat. Crust., iii. 388.
Monoculus macrourus, *Genelin*, Syst. Nat., 3008, No. 65.
Monoculus macrourus, *Manuel*, Enc. Mith., vii, 733, No. 68.
——— *Fabricius*, Ent. Syst., ii, 499.
Camptocercus macrourus, *Baird*, Ann. and Mag. Nat. Hist. ii; Trans. Berw. Nat. Club. ii, 150; British Entomost. p. 128.

Description.—Carapace pear-shaped, transparent, finely lined longitudinally, sinuated on the lower margin, which is ciliated for most of its length. Head rather small, with a short, blunt beak projecting straight downwards. Superior antennæ rather large, situated about half way from the extremity of the beak to the body. Inferior antennæ long, with long setæ at the extremity, eyes small, first pair of feet large, abdomen very long and slender, serrated with well marked teeth on the posterior edge and terminating in the usual pair of claws. The extreme length and narrowness of the abomen formed the basis of the genus *camptocercus* of Dr. Baird, this species being the only one described under it. The intestine is convoluted, and there is an opening near the juncture of the last segment of the abdomen with the rest of the body from which a long vessel begins and extends above the stomach, as at (a) Fig. 1, Plate XV. This species is quite abundant.

Lynceus quadrangularis, Muller.

Bibliography.—Lynceus quadrangularis, *Muller*, Zool. Dan. Prod., No. 2393, 1876.
——— *Latreille*, Hist. Crust., 208.
——— *Baird*, Trans. Berw. Club.
——— *M. Edwards*, Hist. Crust., iii., 388.
——— *Kock*, Deutsch. Crust. L. XXXVI.
Monoculus quadrangulus, *Gmelin*, *Maduel*.
Monoculus quadrangularis, *Fabricius*.
Monoculus striatus(?) *Jurine*.
Alona quadrangularis, *Baird*, Ann. and Mag. Nat. Hist., ii. 92
Trans. Berw. Club, ii. 151;
Entomostraca, p. 131.

Description.—Carapace ovate quadrangular, but somewhat variable, being in some specimens quite abruptly rounded on the posterior margin, while in others it is almost truncate; shell of a yellowish or brown color, heavily marked and ciliated below. Beak blunt, varying in position in different individuals. Abdomen flat, sinuated at the extremity and bearing long claws. Anterior antennæ of moderate size. Eye rather large. Larger antennæ rather long.

Total length between .03 and .04 in. This species is also quite abundant, and if I am right in referring it to the *L. quadrangularis* of Muller, is quite variable. Drawings made from individuals collected at different localites on comparison show minute differences of form and markings. The intestine is strongly convoluted in this species, but the dark color of the shell usually interferes with observations of the organs within.

Plate XV. fig. 2.

Lynceus sphæricus, Muller. (?)

Bibliography.—Lynceus sphæricus, *Muller.*
——————*Latreille.*
——————*Lamarck.*
——————*Desmarest.*
——————*Baird.*
——————*M. Edwards.*
——————*Prichard.*
——————*Koch.*
Monoculus sphæricus, *Gmelin.*
——————*Manuel.*
——————*Fabricius.*
——————*Jurine.*
Monoculus infusorius, *Schrank.*
——————*Eichorn.*
Chydorus Mulleri, *Leach.*
Chydorus sphæricus, *Baird*, Ann. and Mag. Nat. Hist. ii. 89, t. 2; Brit. Entomst. p. 126.

Description.—Baird's description of this species is applicable to any one of several almost equally, and the only recourse seems to be a reliance on the figure he gives with which our species seems to correspond quite well.

The shell is round and nearly blunt behind, the antennæ are quite small, so that the animal rolls slowly along like a corpulent sailor on land. Not enough attention has been devoted to this and the following species of the genus. Length, .03 in. Plate XIII, fig. 2.

Lynceus sp.?

See L. (Pleurus) trigonellus, P. uncinatus etc. of Baird.

The animal figured in Plate XII, Fig. 3, evidently belongs to the genus *Pleuroxus* of Baird. In examining several specimens the turned up beak was found in several cases while in others it was seen as represented at (3a) of the same plate. Dr. Baird separated two species on the ground of this variation, but it does not seem to be a specific character. The length is .03 in. in the species seen, and except that the shell is longer in proportion, agrees pretty well with L. trigonellus, Muller.

Lynceus sp.?

Another member of the genus differing from any description met with is shown in plate XVI. It is the smallest form seen, not exceeding .02 in. The feet are proportionally large, as is the eye, while the antennæ are quite small.

FAMILY Bosminidæ.

This family has been removed, by Prof. Dana, (justly it would seem to us) from *Dahpnidæ*. The general appearance is unique, and the characteristics of the superior antennæ places the only member in the single genus composing this family at quite a distance from Daphnia and its allies.

Characteristics.—Foliaceous feet, ten in number; anterior antennæ elongate and many-articulate.

GENUS Bosmina.

Bibliography.—Daphnia, *M. Edwards.*
——— *Desmarest.*
——— *Baird.*
Monoculus, *Jurine.*
Lynceus, *Muller.*
——— *Latreille.*
Bosmina, *Baird*, Trans. Berw. Nat. Club, 1845; Ann. Mag. Nat. Hist. VI., 412.

NOTE. (Name)—"Bosmina," a daughter of Fingal.

Generic characters.—Superior antennæ long, curved, cylindrical, consisting of many small articulations, and projecting from the extremity of the beak; inferior antennæ small as compared with size of the body.

Bosmina longirostris.

Bibliography.—Lynceus longirostris, *Muller*, Zool. Dan. Prod., No. 2394; Entomost., 76.
———*Latreille*, Hist. Nat. Crust. IV., 206.
———*Fabricius*, Ent. Syst., ii., 499.
Monoculus cornutus, *Jurine*, Hist. Nat. Monoc.
Daphnia cornuta, *Desmorest*, Cons. Gen. Crust.
———*Baird*, Ann. Mag. Nat. Hist. ii., 257.
———*M. Edward*, Hist. Nat. Crust., iii., 382.
Bosmina cornuta, *Baird*, Trans. Berw. Nat. Club.
Eunica longirostris, *Koch*, Deutsch Crust., h. XXXV. t. 23.

Description.—General form varying from nearly square to an irregular pear shape (the large portion anterior); carapace terminated on the lower posterior margin by short, curved spines. Head of moderate size, eye large, superior antennæ long, projecting from the beak, consisting of many articulations, the seventh joints furnished with setæ. Inferior antennæ small. Ova few.

The length of this animal is less than .02 in., which makes it a difficult matter to clearly discover the structure of the organs.

The superior antennæ are nearly immovable, and being closely in juxtaposition, give the appearance of a long, jointed beak or trunk. In fact the first idea

suggested by this bizarre creature is a peculiar burlesque on the elephant. It requires favorable light and a high power to study the nature of the antennæ. The feet are apparently wider than in Daphnia. Under a favorable light, the carapace is seen to be reticulated with hexagonal cells (at least near the edge) and is covered, in some specimens at least, by exceedingly minute tubercles. The motion is steady, progressive, and not saltatory, as in many *Daphniæ*, which is due (as in Lynceæ) to the shortness of the antennæ. The species from which this description is drawn may be distinct from the *longirostris* of Baird, but on comparing both alcoholic specimens and drawings made from living specimens, no differences of importance were detected. The reticulated and tuberculated nature of the shell may be a local variation, or may have easily escaped his notice. The form of the shell demonstrably varies, and so probably does the number of apparent joints to the superior antennæ. The species was found in only one locality, having been dipped with a bottle from the bottom through the ice. but the time of collection is lost. Later, careful search was made during autumn, but no specimens rewarded the pains. The markings, and jointing of the antennæ would make good tests for microscopes of moderate power, for such as are interested in this subject.

Habitat.—Johnson's lake, Minneapolis.

(See Plate XVII.)

TRIBE III. CYPROIDEA. Dana.

Characters.—Dana gives the following: "The Cyproidea differ from all other crustacea except the *Lernæoids* [and *Rotatoria*] in the absence of the pairs of appendages belonging to all the normal cephalothoracic segments posterior to the eighth, that is, to the six posterior of these segments. The last two of these six pairs are obsolete in all the *Lophropoda;* and in the *Cyclopoidea* and *Daphnioinea* the first four of them are natatory and foliaceous, together with also another pair, next anterior in most species. The pairs of appendages present in the Cyproidea posterior to the mandibles, in number four pairs, are divided variously between mouth and legs." This tribe embraces two families, only one of which is represented in our locality, and aside from the general characters of the oceanic family we must confine ourselves to the other.

FAMILY I. Cypridæ. Dana.

Characters.—Antennæ of the second pair subterete, three to five-jointed. Mandibles two-branched, the main branch or body, denticulate at the extremity, the minor branch, or palpus several-jointed, palpus remote from the apex of the mandible; eyes with their pigments united, minute, with spherical lenses. Feet either two or if more, slender and pediform.

SUB-FAMILY 1. CYPRINÆ. Dana.

Bibliography.—Cypris, *Muller* and others.

Cyproides (in part) *M. Edwards*, Hist. Nat. Crust.

Cypridæ (in part) *Baird*, Trans. Berw. Club. ii, 153.

Cypridæ, *Baird*, Brit. Entomost., p. 130.

Characters.—Feet, two pairs; anterior slender and pediform, posterior weak; Abdomen elongate, bearing two clawed appendages.

The cyprinæ, in common with all the members of this tribe are enclosed in a brittle, mussel-like shell which hides from view, in general, all of body and members, except the extremities of the two pairs of antennæ and a pair of feet. They vary in size from an animal of sufficient size to be easily watched with the naked eye, and resembling a small *Unio* in shape and color, to creatures so minute that it is with the greatest difficulty that the valves of the shell are removed without destroying the parts within completely. This peculiarity of these animals renders them among the most difficult in all this order to study. The shell is usually opague, and sometime beautifully colored and fringed. When, however, the soft parts within are separated from the crustaceous envelope the beauty and peculiarity of the structure well repays the student. The shell is composed of two valves, which are only united for a short part of the dorsal margin, and which are held together by muscles which are under the control of the animal. These valves are symetrical with each other in general and are covered by a sort of varnish, which seems to repel the water so that when the creature takes air within the valves of the shell, and hence floats upon the surface it is impossible to cover it with water to prevent the glitter from the surface, while the air within prevents, by its refraction, a view of the interior in such as are transparent. On removing the shell the body is seen to consist of two parts, of which the anterior, or cephalothorax, is considerably the larger and is furnished with organs as follows: first, the eye, situated on the upper portion of the anterior aspect, which, according to Baird, has no crystallines. By Dana, however, two lenses are described; second, the superior antennæ, which are in general seven-jointed, and setigerous. These organs are always kept in vigorous motion when the animal swims. The setæ are sometimes plumose; third, the inferior antennæ. These are more like feet than antennæ and are five-jointed, and in one genus abundantly covered with (sometimes plumose) setæ. In all they are furnished with strong claws at the extremity; fourth, mandibles, which are composed of two parts, the main portion consisting of a triangular plate terminating below in a curved neck, bearing at the end a number of teeth. From the base of the neck arises a second portion, which is three or four-jointed and setigerous. From the end of the first joint of this palpus springs a small plate (branchial?) which has several fine filaments; fifth, first pair of maxillæ. These organs consist of a basal portion and the proper maxillæ which are of two rami, each ramus being furnished with setæ. There is also an attached branchial plate extending within the shell directed upwards and backwards; sixth, maxillipeds. These organs vary in Cypris. As figured by both Dana and Baird, they are of two rami, or have a "maxillary process," but in the species of *Candona* here figured they seemed to resemble the maxillipeds of the *Cyclopoidea*; seventh, first pair of feet. These are five-jointed and terminate in a strong hooked-claw which is directed forward, opposing the second pair of antennæ.

The second portion of the body or abdomen has but two sets of appendages, which are the second pair of legs and the caudal stylets. The second pair of legs are slender and four-jointed, and are directed backward along the abdomen. The caudal appendages are long and terminate in two claws. The anus opens between them. Of the other organs little or nothing is known. Baird was in doubt whether they were hermaphrodites or one copulation sufficed to render the mother and her offspring fertile for life, as in *Daphnia*. I have, however,

observed copulation in *Cypris*, and the peculiar organs represented in the plate of *Cypris* seem to be restricted to the male, so that it is certain that the sexes are distinct.

These minute creatures moult frequently, casting off in the process the minutest hairs as well as the shell.

This sub-family contains two genera, both of which are represented by a few abundant species within our limits.

GENUS 1. **Cypris,** Muller.

Characters.—Antennæ of the second pair furnished at the end with a bundle of long hairs, by means of which the animal swims freely in the water. The structure is that of the sub-family.

It is very difficult to characterize the species, and it will be necessary to rely chiefly on the figures, since there is little variation in internal structure between the species.

Cypris vidua, Muller. (?)

Bibliography.—Cypris vidua, *Muller*, Zool. Dan. Prod. No. 2384.
————*Latreille*, Hist. Nat. Crust., IV. 245.

————*Bosc*, Man. d'Hist. Nat. Crust.
————*Desmarest*, 385, t. 55, p. 4.
————*Baird*, Trans. Berw. Club, ii. 152.
————*M. Edwards*, Hsst. Nat. Crust., iii. 399.
Monoculus viduus, *Gmelin*, Linn. Syst. Nat., 3002, No. 42.
————*Manuel*, Enc. Méth., vii., 726, No. 36.
————*Jurine*, Hist. Nat. Monoc., 175.
————*Rees*, Cyclopedia, art. Monoc.
Monoculus viduatus, *Fabricius*, Ent. Syst., ii. 496.

(I here give Dr. Baird's description verbatim for comparison with the figure.)

Description.—"Shell of oval form, a little sinuated on the under margin, and beset all round with dense, fine, short hairs. The color is dull white, and the valves are distinctly marked with three black, somewhat waved fasciæ running transversely across the shell at equal distances, the most anterior of the three being smallest. Posterior margin rather narrower than anterior."

This species, if it be the one figured beyond, is the most abundant of this family here, inhabiting all the pools and lakes. It is quite small, appearing as a small speck, either floating on the surface or swimming rapidly about, with a sort of running motion, reminding one of the haste of an excitable man, in its seeming uncertainty and briskness. In figure 1, the shell is represented as transparent, to indicate the position of the organs. The size and shape of the dark bands upon the shell vary in different individuals.

(See Plate No. XVII. fig. 1.)

Cypris neglecta, Herrick.

This species is apparently different from any other which I have seen described The size is very small, little exceeding .01 in. in length. The shape is, as seen from the side, a very perfect oval, not sinuate below, but narrower posteriorly

than in front. The lower edge of the shell is rather straight, while the upper narrows behind, to form the more acute apex. The color is dull white, without markings of any kind. The shell is more gibbous than any of the other species seen, and is quite glabrous.

The antennæ and feet are not protruded as far as in vidua. This species is also abundant.

Plate No. XVII. fig. 2.

GENUS **Candona,** Baird.

Baird's Brit. Entomost., p. 151.

Characters.—Distinguished from Cypris by the absence of the tuft of long hairs on the secondary antennæ, and the consequent creeping method of locomotion, and, perhaps, by a difference in the form of the maxillipeds.

Candona ornata. Herrick.

Resembles in size C. lucens of Baird, and is of somewhat the same shape. The lower posterior margin is acute, the lower margin is sinnated and the whole margin is beset with hairs. The edge of the shell is also bordered by a series of of markings; the antennæ of the second pair are totally without setæ as far as observed; the shell is white and opaque with pearly lustre. This species is not very gibbous. (See Plate No. XX., Fig. 1.)

Candona (?) elongata. Herrick.

Shell reniform, very elongate, white, glabrous; the umbones of the valves are about two-thirds the distance from the anterior to the posterior dorsal margin; the portion of the shell anterior to the prominence thus formed is narrower than the posterior. It is questionable whether this be a member of the genus *Candona* or in reality a *Cypris*. The animal is quite large and the structure was more clearly made out than in the above. The same pair of bodies seen in the male *Cypris vidua* was found in this animal, the form of the maxillipeds, moreover, was found to differ from that given under the genus *Cypris* by Dana. It is to be hoped that some one may be able to devote a little patient study to this group and clear up the habits and structure as well as the history.

SUB-FAMILY II. CYTHERINÆ.

Cytheridæ, *Baird*, Brit. Entomostraca, 162.

Characters.—Feet six, all slender, alike and pediform.

Genus 1. Cythere, *Muller*.
Shell thin and light, tail short.
Genus 2. Cythercis, *T. R. Jones*.
Shell corrugulate or tuburculate, animal unknown.

FAMILY II. HALOCYPRIDÆ.

This family includs two sub-families and three genera of oceanic species differing in almost all the organs from the above.

SUB-ORDER PHYLLOPODA. (sig. Leaf-footed.)

Bibliography.—Phyllopoda, *Latreille*, Hist. Nat. Crust., IV., 130, 1802.
——————*Leach*, Dict. Sc. Nat. XIV., art. Entomost.
——————*M. Edwards*, Hist. Nat. Crust., iii., 351.
——————*Desmarest*, Consid. Gen. Crust., 357.
——————*J. E. Gray*, Synops. Brit. Mus., 1842.
——————*Burmeister*, Organiz. of Trilobites, 34.
——————*Lucas*, Explor. Sc. de l'Algerie, Crust., 81.
Phyllopa, *Latreille*, Cuv. Règne Anim., IV., 171.
Branchiopodes Lamellipedes and Branchiopodes, *Geans* (in part), *Lamarck*, Hist. An. S. Vert., V.

Characters.—Number of abnormal feet greatly multiplied.

TRIBE I. ARTEMIOIDEA.

Family 1.—Artemiodæ (Branchipodidæ.)
Family 1.— Nebaliadæ.

TRIBE II. APODOIDEA.

Family 1.—Apodidæ.

TRIBE III. LIMNADIOIDEA.

Family 1.—Limnioidæ (Estheridæ. ?)

ARTEMIOIDEA.

Bibliography.—Branchipiens, *Edwards.*
Branchiopoda, *Leuch.*
Branchipodidæ, *Baird.*

Characters.—Cephalothorax many-jointed, either covered by the carapace or not. Appendages of the cephalothorax many, foliaceous and branchiform. Eyes peduncled.

Artemioidea includes *Chirocephalus, (Branchipus) Eulimene, Artemia, Branchinecta, Eubranchipus, Streptocephalus, Nebalia, etc.* These agree in having peduncled eyes, divided posterior thoracic legs and a straight abdomen terminated by spines or plates. This tribe is quite naturally divided into the two families of which *Nebalia* constitutes the one, while the remaining genera fall quite readily into the other.

FAMILY Artemiadæ.

Bibliography.—Branchipoda, *Leach*
Branchipiens, *Edwards.*
Branchipidæ, *Burmeister.*
Branchipusidæ, *Baird*, 1845.
Branchipodidæ, *Baird*, later.
——————Most modern authors.

Characters.—Cephalothorax many-articulate as far as the head, but nowhere covering the body. Feet foliaceous and numerous.

Dana subdivides this family, forming of the genus *Eulimene*, which has twenty-two branchial feet, the sub-family *Eulimeninæ*, leaving *Chirocephalus*, *Artemia*, etc., as the

SUB-FAMILY CHIROCEPHALINÆ.

Characters—Body slender, abdomen long and many jointed, antennæ of the second pair in the female very short and broad, while those of the male are prehensible.

GENUS **Chirocephalus.** (Sig. hand-headed.)

Bibliography.—Chirocephalus, *Prevost*, Jour. de Rhys., lvii., 37, 1803.
——— *Thompson.*
Branchipus, *M. Edwards.*
——— *Fischer.*
——— *Latreille.*
——— *Desmarest.*
——— *Guerin.*
——— *Lamarck*, etc.
Ino, *Schrank*, 1803.
——— *Oken.*
Cancer, *Shaw.*

Some member of this sub-family was found, during the autumn months, in a pool by the road-side but no accurate drawings were made and attempts to re-discover it have failed, so it remains uncertain what species it was. A figure is given of *Chirocephalus diaphanus* and the following discription, mostly from Dr. Baird's work, will serve both for a better understanding of the genus and for comparison, when other specimens are obtained.

The head consists of two segments, the posterior of which is more slender than the anterior, and is usually called the "neck."

The antennæ are very important in the whole group, as furnishing basis for classification. The superior antennæ are alike in male and female, and are filiform, straight, many-jointed, and very flexible. At the extremity are a number of small setæ. The joints of these antennæ are with difficulty seen. The length equals the head. The inferior pair of antennæ are curious organs, from which the genus derives its name, and have been mistaken for madibles and various other entirely different organs.

They are essentially prehensile organs, and consist chiefly of two large appendages, which occupy the forepart of the head, and are curved downward toward the thorax. They are articulated about the middle of their length; the first joint being large and fleshy and having a short, movable, conical appendage on its external edge; the second being curved, cylindrical, somewhat flattened at its extremity, and bearing a strongly toothed process at the base.

Arising from the base of the first joint of each of these appendages is another set of organs, called by Shaw "the trunk." These each consist of a long, flat, curved, very flexible body, composed of many short joints the edges of which are acute, giving a toothed appearance to this organ. From the outer edges of these arise four long and flexible appendages, which are toothed near the end, and also a triangular plate which is folded like a fan when not in use. (This is removed in fiigure b of plate 1, but shown at d.) These organs are generally carried rolled under the head, somewhat in the manner of the proboscis of a butterfly, being only visible externally as a protuberance.

These prehensile organs are used in retaining the female during copulation. In the female they are much more simple, being simply two flexible, horn-like bodies, carrying none of the appendages which pertain to the male.

The eyes are large, convex and compound, and are situated on rather large peduncles, which are movable; the mouth consisting of a labrum, a pair of mandibles and two pairs of jaws.

The thorax consists of eleven segments. each bearing a pair of branchial feet, which are large and foliaceous, and consist of three joints. The first is the largest, and has on its lower edge a semicircular branchial plate, which is furnished with about forty plumose hairs; the second joint of the feet bears on its inner side three projections, each of which sends off long hairs; the third joint is long, bearing plumose setæ.

The abdomen is composed of nine segments, which are devoid of appendages, except the two terminal plates, which are beset on their edges with plumose setæ. In the female there is an external oviferous pouch.

The dorsal vessel or heart, commences near the head, and traverses the whole length of the body. When fully grown it is upwards of an inch in length, slender, of a cylindrical form, and nearly transparent. The male has a reddish tinge throughout. The tail is of a beautiful red; the basal joint of the prehensile antennæ a bluish green tipped at the end with red. The back of the female is bluish, and the ovary brown.

These are beautiful animals, and may be seen in fine weather balancing themselves, near the surface of the pools they inhabit, by means of their branchial feet; but when disturbed they strike the water from right to left, and dart away like a fish, to conceal themselves among the weeds at the bottom of the pond.

GENUS **Branchineota.**

Characters.—Form rather slender, with the medium appendages longest, so as to somewhat resemble *Artemia* in outline, but larger; male with rather slender, rounded, two-jointed claspers. Egg-pouch much elongated.

GENUS **Eubranchipus.** (Verrill.)

Characters.—Body robust; made with large head and very stout claspers; firs joint of claspers much swoolen, capable of retracting bass portion of the second joint into their cavity; second joint stout at the base, in the typical species with a large tooth on the inside, the outer portion tapering, rather obtuse. Front of head between the claspers bears two thin, flat tapering appendages. Caudal appendages long. Egg-pouch short and thick.

GENUS **Streptocephalus.** (Baird.)

Characters.—Male claspers long, three-jointed, tortuous; terminal point subdivided more or less into two branches, or bearing slender appendages. Male organs long and slender. Egg–pouch elongate or conical.

GENUS **Artemia.**

Bibliography.—Artemia, *Leach*, Dist. Sc. Nat., XIV.
Artemisus, *Lamark*, Hist. An. S. Vert. (2d edit.)
Artemis, *Thompson*, Zool. Res., 104.

Characters.—Clasping organs three-jointed; egg-pouch short, broad; living in more or less saline waters.

The members of this genus, which will be often referred to, are peculiarly interesting from the way in which they show the great and sudden changes that a change in the invironment, is competent to effect in animal forms.

Three species are known in the United States, one of which is found in the eastern states, another in Utah, and still another in California, viz: *gracilis*, *monica*, and *fertilis*.

SUB-FAMILY EULEMENINÆ.

Characters.—Abdemen almost obsolete; both pairs of antennæ filiform.

GENUS **Eulimene.** *(Latreille.)*

FAMILY NEBALIDÆ.

Characters.—Antennæ large and ramiform; eyes peduncled; feet twelve pairs; carapax large, enclosing head, thorax and part of the abdomen, as in a bivalve shell.

GENUS **Nebalia.**

Bibliography.—Nebalia, *Leach*, *Thompson*, *Desmarest*, *Latreille*, *M. Edwards*, *Bosc*, *Lamarck*, etc., etc.
Cancer, *O. Fabricius*, *Herbst.*.
Monoculus, *Montagu.*
Myses, *Olivier.*

Being the only genus in the family, the above characters also characterize the genus.

TRIBE II. APHODOIDEA.

Bibliography.—Apusiens (in part), *Edwards.*
Apodidæ, *Burmeister.*
———— *Baird.*

Characters.—Body straight; cephalothorax covered by a scuteliform shell; posterior appendages of the thorax lamelliform; abdomen many-jointed; eyes sessile.

FAMILY **Apodidæ.**

Bibliography.—Apus, *M. Edwards*, Hist. Nat. Crust., iii., 356.
Phyllopoda, *Leach*, Edin. Encyclop. VII., art. Crustaceology.
Apodidæ, *Burmeister*, organization of Trilobites, 34.

Characters.—Of large size, with a rounded carapace partially covering the base of the abdomen, which is elongate and ends in two many-jointed, caudal filaments; about sixty pairs of swimming feet; antennæ rudimentary; first maxillipeds antenniform.

GENUS **Apus.** (Sig. without feet.)

Bibliography.—Apus, (see above for family.)
Monoculus, *Linnæus*, *Fabricius*.
Binoculus, *Geoffroy*, *Leach*.
Limulus, *Muller*, *Lamarck*.
Trilopes, *Schrank*.
Characters.—Antenniform maxillipeds long; telson squarish.

GENUS **Lepidurus.**

Characters.—Body much shorter than in *Apus*. First maxillipeds shorter, and a long, spatulate, keeled telson projecting beyond the insertion of the caudal filaments.

Query—Should not this be reunited with *Apus?*

TRIBE III., LIMNADIOIDEA.

Bibliography.—Apusieus, (in part), *Edwards*
Characters.—Body covered completely by a carapace which includes abdomen and head; eyes sessile, like *Cyproidea* in appearance.

FAMILY LIMNADÆ.

Characters.—Body compressed, with ten to twenty-seven feet, inclosed in a bivalve shell.

GENUS **Limnetis.**

Characters.—Shell small, round globose, without lines of growth or umbones; feet-bearing segments ten to twelve.

GENUS **Limnadella.**

(Uncertain. The species upon which it was founded are not now known.)

GENUS **Estheria.**

Shell oval, more or less globose, *Cyclas*-like with numerous lines of growth, amber-colored; animal without a "*haftorgan*"; second antennæ, with from eleven to seventeen joints to the flagella; from twenty-five to twenty-seven segments behind the head; feet twenty-four to twenty-eight; anterior feet in the males with clumsy hooks.

GENUS **Limnadia.**

Shell large, with four or five lines of growth, sub-triangular or broadly ovate; animal with a knob-like projection ("*haftorgan*") above the eyes; second antennæ with nine or ten joints to the flagella; feet eighteen to twenty-six; body much smaller than in *Estheria*.

GENUS Cyzicus.

(Am not familar with any description of the generic characters.)

Remarks on the Sub-Order.—The species of this sub-order are scattered rather sparingly over the world, and many of them are dependent on peculiar circumstances for their perfect development, as in the case of *Artemia* (or Brine Shrimp) which is found in the waters of salt lakes and in the brine tubs of salt manufactories.

Of the family *Artemiadæ* several species occur throughout the United States. No *Chirocephalus* has been found west of the Rocky Mountains. *Artemia* occurs in many places, as, one in Great Salt Lake, one in Mono Lake, California, and one in the eastern U. S. The genus *Branchinectas* which has a representative in Greenland and in Labrador, has also a species in Colorado, 12,800 feet above the sea. I am not informed that any species of *Nebalia* occurs in North America.

The tribe *Limnadioidea* is without a known representative east of the Mississippi and north of San Domingo. But in Greenland and the arctic regions, *Lepidurus glacialis* is found. West of the Mississippi and east of the Rocky Mountrins are three species of *Apus*, and there has been another found on the Pacific, at Cape St. Lucas. Geologically, the genus is found in European rocks in the Triassic, and our own rocks will probably furnish species.

In the *Phyllopoda* the abdomen and thorax are merged together, and in all but the family *Artemiadæ*, there is a large carapace covering most of the body. In the *Limnadidæ* this shell is large and double, and resembles the small *Cyclas* shells of fresh water, and are often collected by Conchologists as such. The eggs are round or polygonal, and are dense and tough-shelled. The eggs are carried in an ova-sack similar to that of *Cyclops*, or in the *Limnadiadæ*. They are borne under the shell, as in *Daphnia*, etc. The young, as in other *Entomostraca*, hatch from the egg in the "Nauplius stage" described more particularly under *Cyclops*. The difference between the sexes is usually sharply defined. The process of reproduction is very interesting in many species of this sub-order. The normal method of reproduction is perhaps less common than what is known as parthenogenesis, or virgin reproduction. The eggs are produced by a simple budding process from the ovary, without fertilization by the male. The proportion of males to females is very small. In some localities the males are entirely absent. In *Artemia* the amount of saline matter in water seems to vary the comparative number of males. This affords a curious parallel with the sexual changes in the pupa of the honey bee. The saltness of the water not only affects the young, the form of the parent also varies. Schmankiewitsch found near Odessa, Russia, a species of Artemia, and by studying it discovered that it changed its form to correspond with the greater or less saltness of the water. Toward the end of the summer, when the rain and cold weather set in, the *Artemia* increases in size, and the July generation has many differences from the later ones. He then attempted to verify his observations by artificial breeding. He increased the concentration in one case and lowered it in the other, and found that after a series of generations the two sets of animals varied between themselves, and also both differed from those of the pond from which they came. He also learned that males were only produced in water of medium strength.

In the genus *Apus* similar parthenogenetic broods are produced. Siebold's experiments, which have been made with great care and minuteness, have established this fact beyond doubt.

There is great need of further investigation in this subject, and we are glad to learn that it is about to receive attention from so competent hands as Dr. Packard's.

The systematic position of the sub-order is still a matter of doubt, and it is not yet possible to make any positive classification of the divisions of the *Entomostraca*.

(See Plates XVIII. and XIX.)

ADDENDA.

Since these pages were written the Bulletins of the Illinois Museum of Nat. Hist. have come under my notice, which, aside from other interesting matter, contain descriptions of many new species of crustacea inhabiting the water of that state. Fine descriptions are given of the following species of Entomostraca, to which the student is referred, viz:

Eubranchipus serratus, Forbes.
Canthocamptus Illinoisensis, Forbes.
Diaptomus Sanguineus, Forbes.
Eubranchipus Bundyi, Forbes.
In Bulletin No. 2, Prof. Forbes describes or mentions the following:
Eurycercus lamillatus, Mull.?
Bosmina, sp.?
Ceriodaphnia angulata, Say.
Daphnia pulex, L.?
Daphnia galeata, Sars.

Later study shows that there is yet much to be done in simply verifying the species which occur here, not to mention the ever remaining opportunity for more minute study of the structure of known forms, for aside from the whole genus *Cyclops*, which has not yet been attempted, and contains numerous species, new species are constantly being met with, among which are those described beyond.

FAMILY PENILIDÆ.

Genus Daphnella. Baird.

Bibliography.—Daphnella, *Baird*, Brit. Entomost., 809.
———— *Dana*, Wilkes' Exp. Crust., page 1267.

Another member of this interesting family has been found since the text was sent to press.

The genus *Daphnella* is characterized by Dana as follows: Posterior antennæ with both rami two-jointed, the shorter ramus often imperfectly three-jointed: Head oblong, not produced beneath, bearing the anterior antennæ near the middle. *Daphnella* differs from *Sida*, which it greatly resembles, even in

minute structure, in the number of joints of the antennæ and from *Penilia*, in having the first joint of the longer ramus shorter than the second.

The branch which is three-jointed in *Sida* is not the one which has the short terminal joint.

Daphnella Winchelli. Herrick.

This species closely resembles *D. Wingii*, Baird, but I have no hesitation in pronouncing it distinct. Length .03 in. Head rather short. Carapace pear-shaped, transparent. Superior antennæ short, but appearing on either side the head when the animal is swimming, they appear to have three setæ at the extremity. Inferior antennæ very long, as long as body. The shorter ramus has four setæ on the terminal joint and one on the first, while the other ramus carries eight on the terminal joint besides one that is much shorter than the others, and the first joint has four.

The tail has long diverging stylets, and seems not to have the minute teeth of the *D. Wingii*. The posterior portion of the front of the shell-margin is ciliated or spined. The back of the head seems to have the same appendage described in *Sida*. Ova two. This species was found in Minnetonka creek and is named in honor of Prof. Winchell.

FAMILY POLYPHEMIDÆ.

Genus Polyphemus. Müller.

Bibliography.—Polyphemus, *Muller*, *Cuvier*, *Latreille*, *Strous*, etc.
————— *Baird*, Brit, Entomost. p. 111.
————— *Dana*, Wilkes' Exp. p. 1266.

Characters—Body incurved toward the head except the posterior portion of the abdomen, which projects backward and is very slender, bearing two long spines at the extremity. Head distinct. Rami of posterior antennæ three, and four-jointed.

Polyphemus occidentalis. Herrick.

Length .25 in. Body excessively incurved, as is the head. Eye large, filling the head. Superior antennæ apparently obsolete. Inferior antennæ small. Jaws two or three-jointed, three-toothed at the apex. Feet, four pairs, first pair long, apparently four-jointed and three-clawed at the end, basal portion ciliated on the posterior margin. Fourth pair of feet nearly rudimentary. The abdomen is very long. Found in "Mud Lake," south of Minneapolis.

Eurycercus lamellatus. Muller?

Several specimens belonging to Baird's genus *Eurycercus* were found, and as far as can be determined they are not specifically distinct from *E. lemellatus*, though they are less in size and have a few minor points of difference.

I append his description, omitting the bibliography:

"Shell of an olive color; rather square-shaped, ciliated on anterior margin; ventricose in centre, and arched on posterior edge. Beak rather blunt and short, superior antennæ stout, somewhat conical, slightly curved and terminating in

six spines, each of which gives out a fine seta. Inferior antennæ short compared with the size of the insect. Anterior branch has five long filaments, three from the terminal, and one from each of the other joints. The posterior branch has short spines on the two basal joints. Eye large. Abdomen very wide and densely ciliated. This is the largest member of the family, its motion is a succession of bounds. This animal is heavy and slothful compared to other species.

PLATE I.

Diaptomus longicornis, Herrick.—Back view of the female and side view of the male. *a*, basal portion of male antennæ showing geniculating joint.

MICROSCOPIC ENTOMOSTRACA.

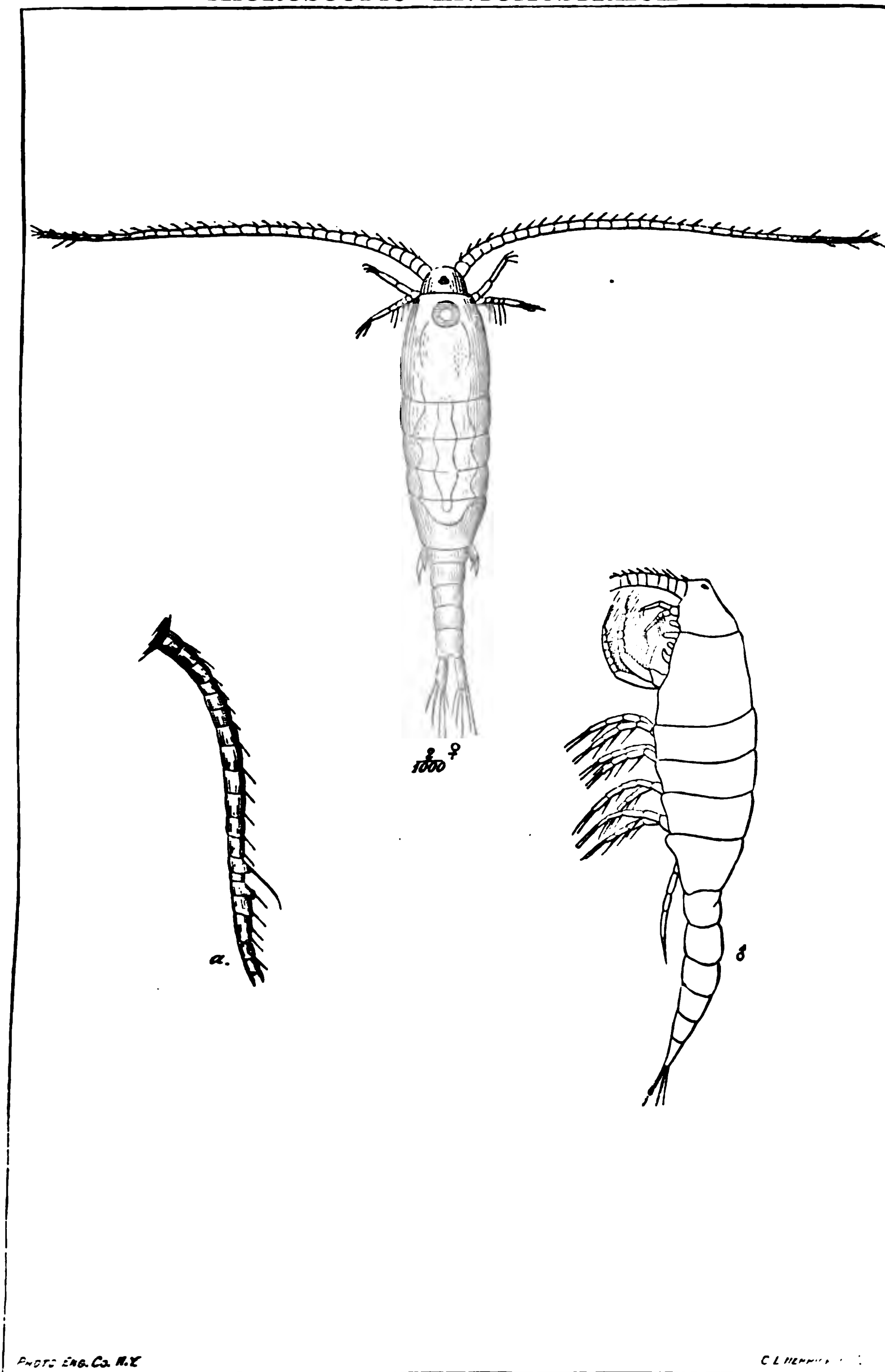

Plate I.

PLATE II.

Diaptomus pallidus, Herrick.—Back view of female. (In this plate the antennæ are represented far too short.) *a*, maxilliped. *b*, fifth pair of feet. *c*, extremity of male antennæ. *d*, extremity of female antennæ.

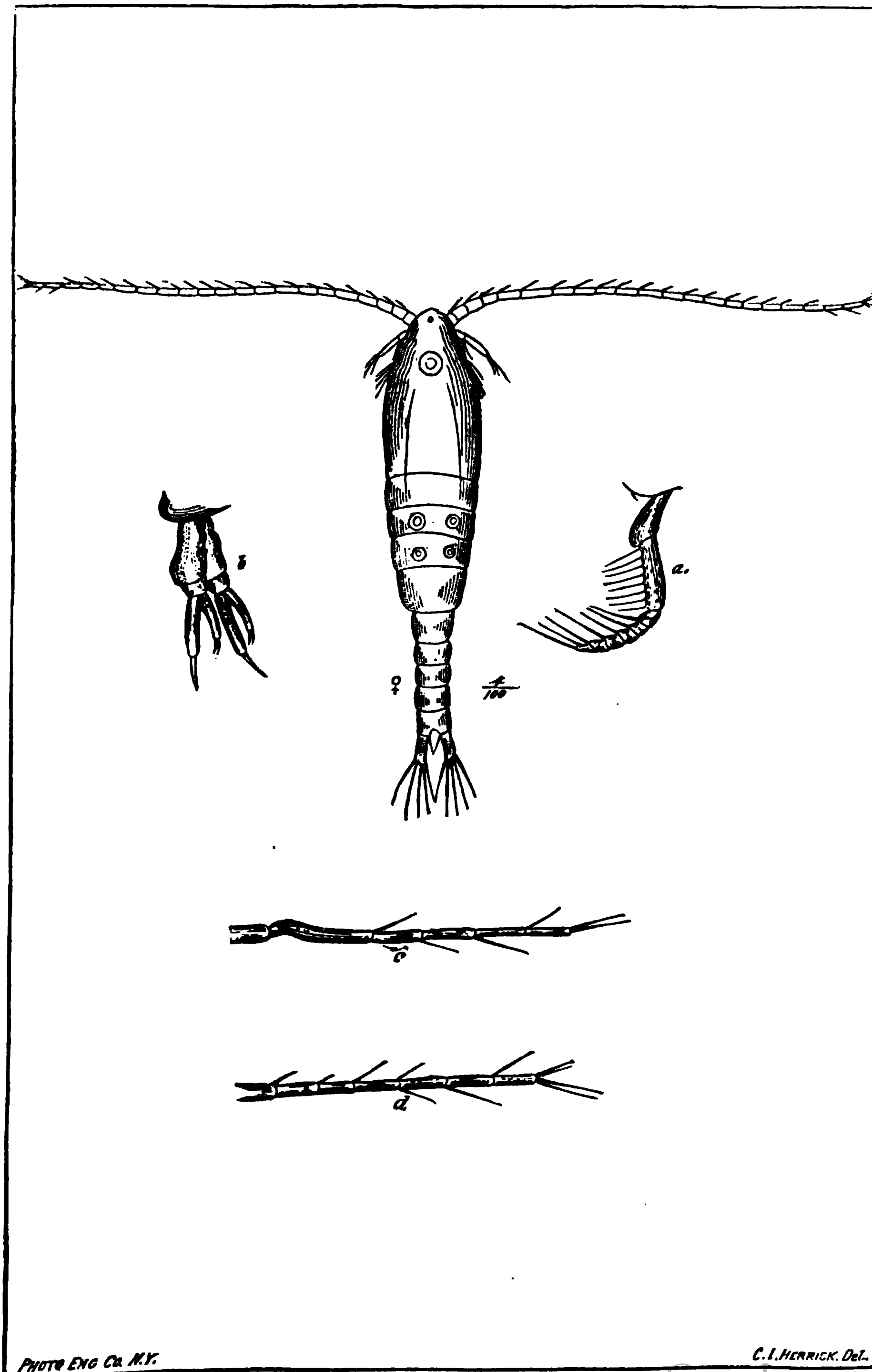

Plate II.

PLATE III.

Cyclops quadricornis, Linn.—1, mature female with egg sacks containing ova. *a*, egg. *b*, young just born. *c*, young eight days old. *d*, young fifteen days old. *c*, young seventeen days old. *a′*, mandible. *b′*, first pair of foot jaws. 2, side view of mature cyclops.

MICROSCOPIC ENTOMOSTRACA.

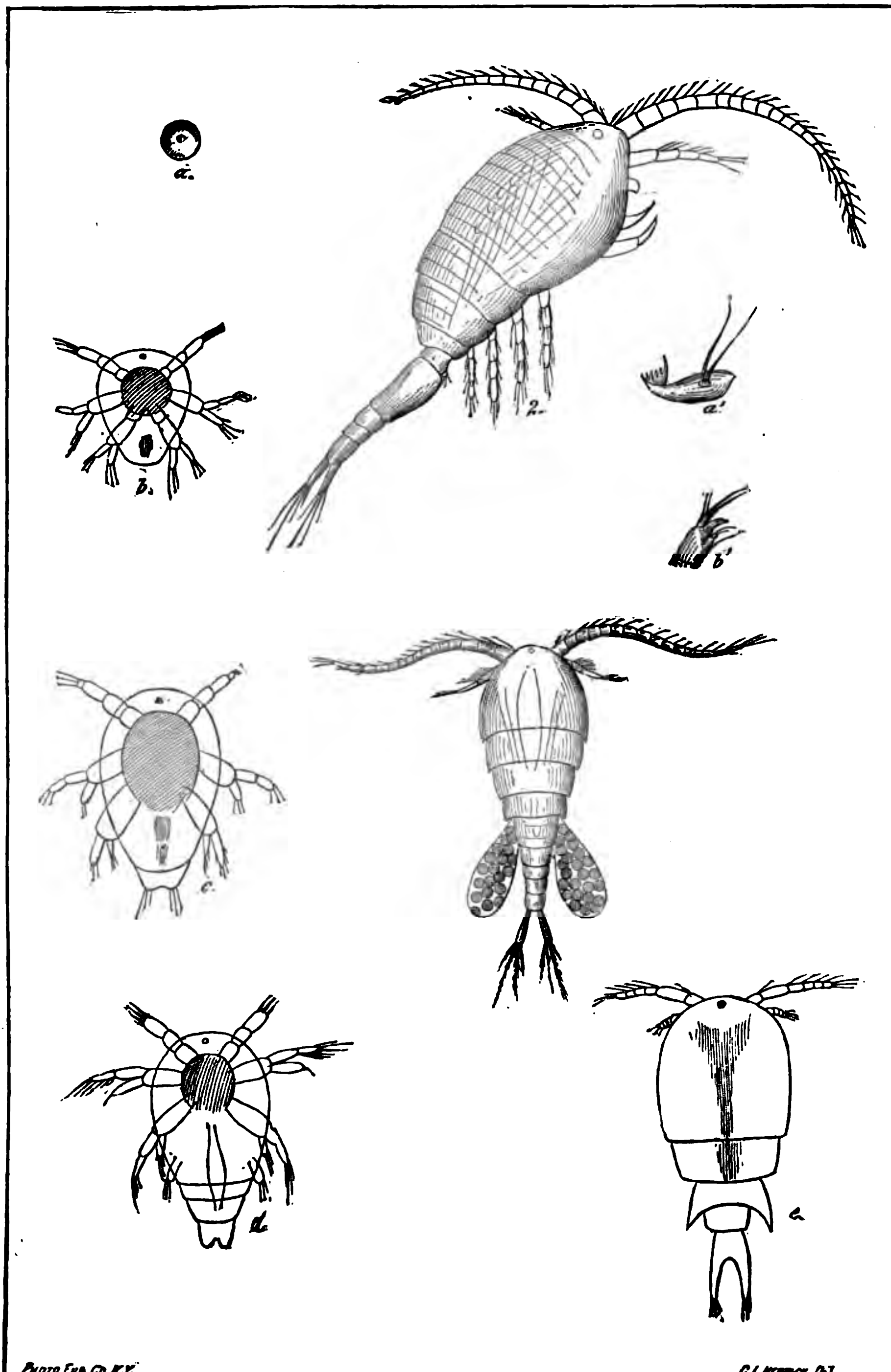

Plate III.

PLATE IV.

Cyclops quadricornis, Var?—*a*, last pair of feet. 1, 2, 3, 4, 5, feet. 6, inferior antennæ.

MICROSCOPIC ENTOMOSTRACA.

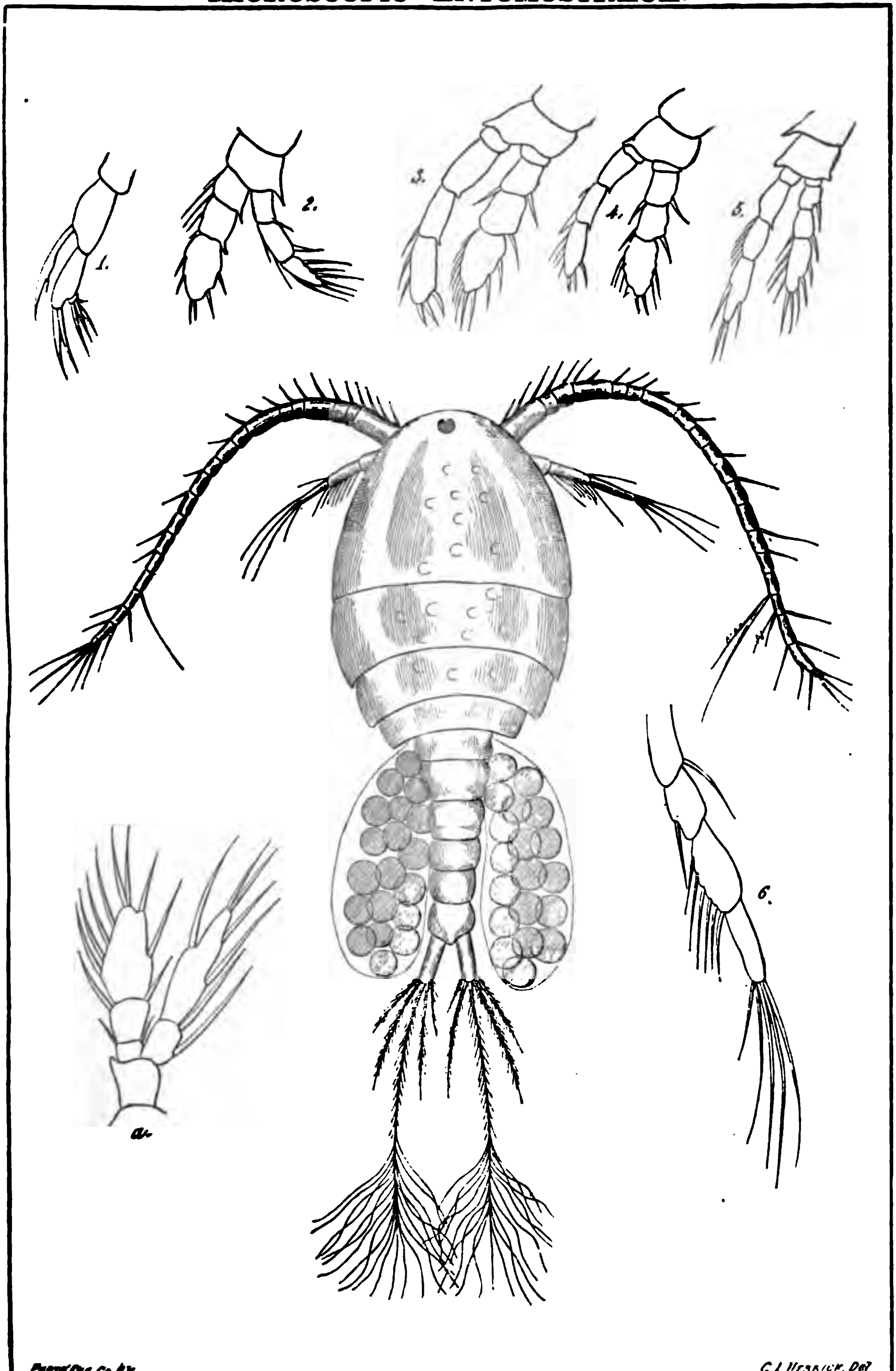

Plate IV.

PLATE V.

a, *Canthocamptus minutus, var. occidentalis*, Herrick, male.

b, do., side view.

c, young, or Nauplius.

d, underview of head of male.

e. external ovary and appendage of female.

f, antenna of male.

g, antennæ of female.

i, foot of first pair.

k, appendage to abdomen of female. (Fifth pair of feet.)

h, foot of second pair.

MICROSCOPIC ENTOMOSTRACA.

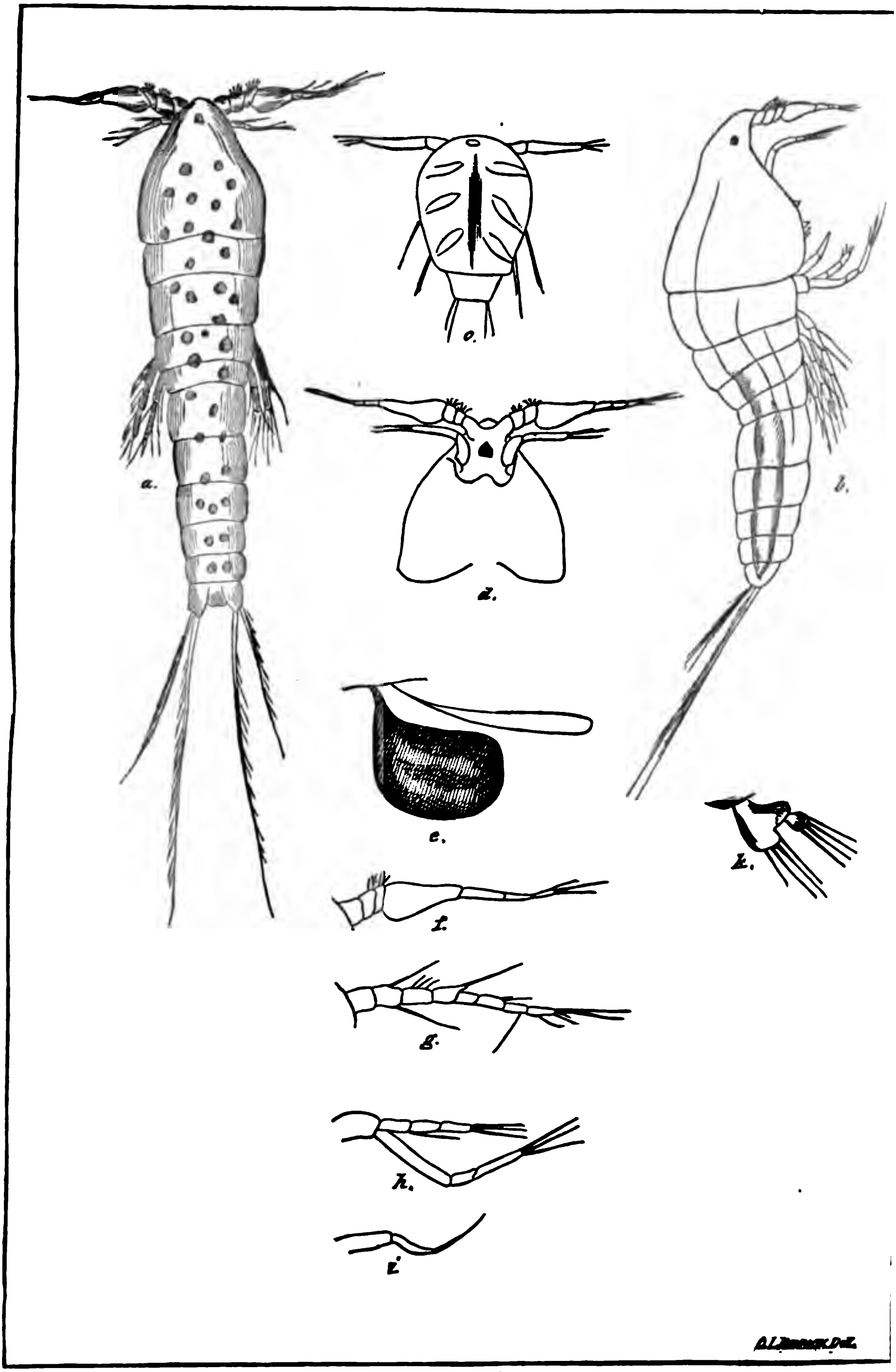

Plate V.

PLATE VI.

Sida crystallina, Straus. *a*, *b*, *c*, feet of first, second and last pairs. *d*, jaw. *e*, extremity of abdomen. *f*, superior antennæ.

MICROSCOPIC ENTOMOSTRACA.

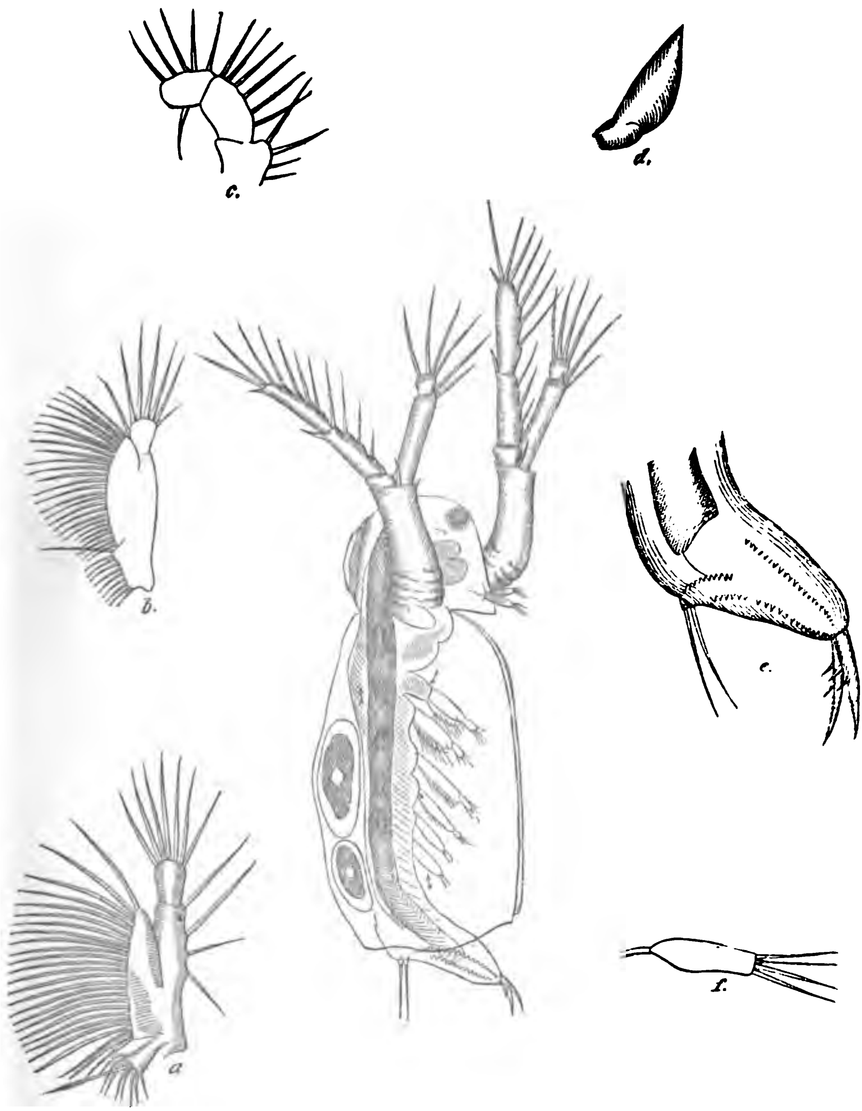

Photo Eng. Co. N.Y.

C. L. Herrick, Del.

Plate VI.

PLATE VII.

1. *Daphnia reticulata.* *a*, superior antennæ, *b*, heart.

2. *Sida crystallina.* *a*, head.

MICROSCOPIC ENTOMOSTRACA.

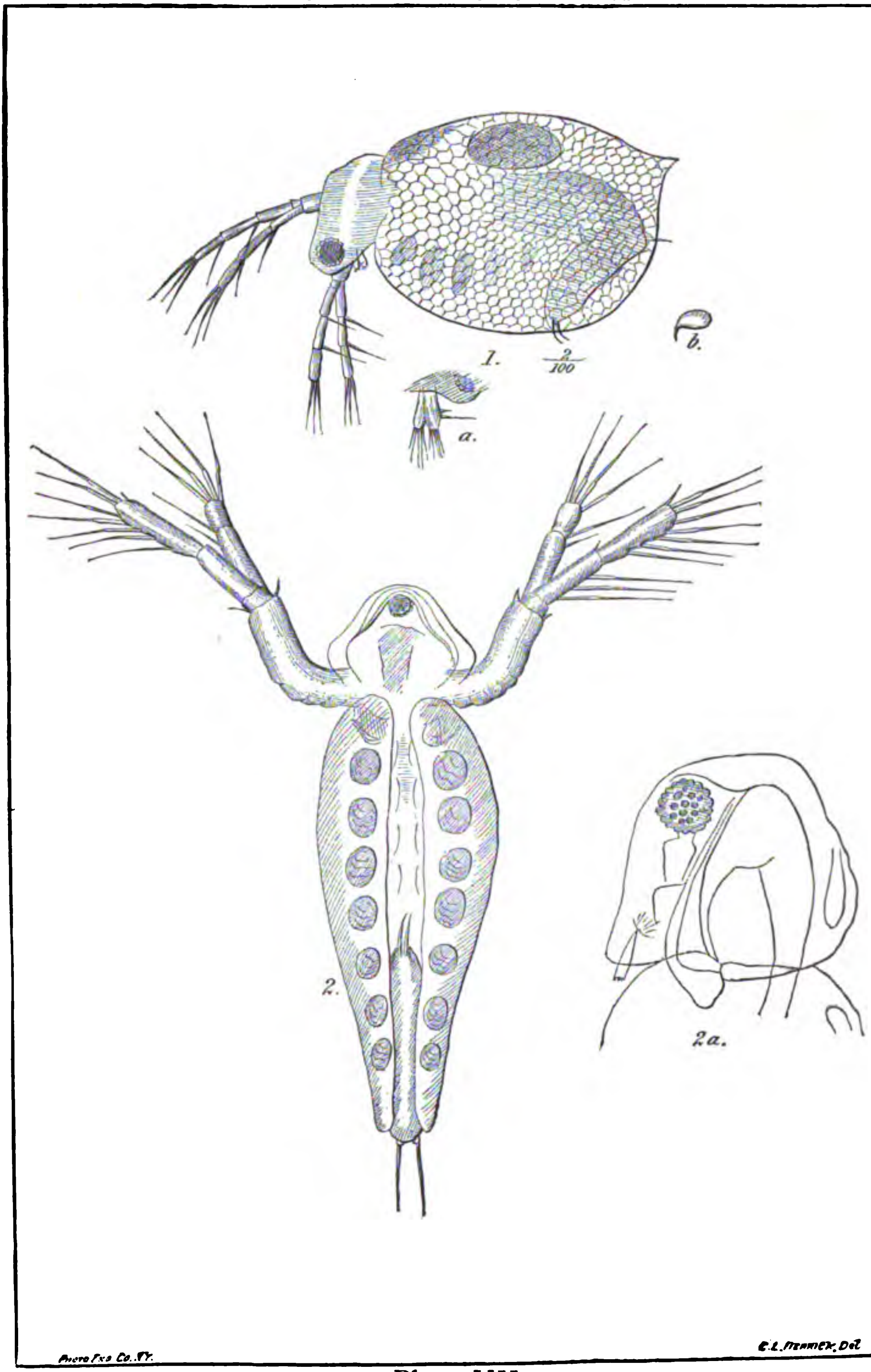

Plate VII.

PLATE VIII.

1. *Daphnia pulex*, var. 1.
2. ——— ——— var. 2.
3. ——— ——— var. 3.
(*a*) foot.

MICROSCOPIC ENTOMOSTRACA.

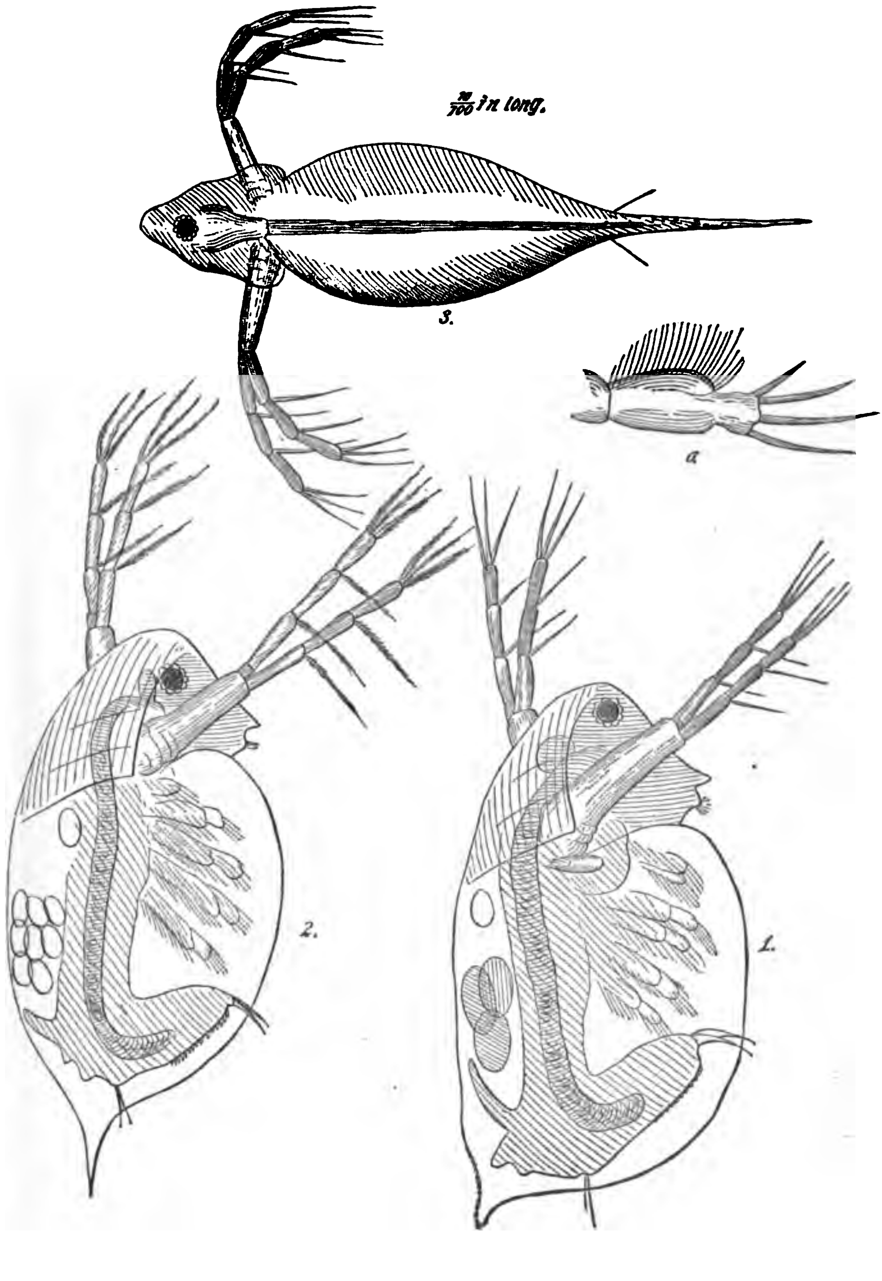

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Plate VIII.

PLATE IX.

Fig. 1. Head of Daphnia Schæfferi showing alimentary apparatus etc., antennæ removed. *a*, heart. *b*, stomach. *c*, cœcum. *d*, superior antennæ. *e*, eye. *f*, labrum. *g*, jaw. *A*, *B*, *C*, *D*, *E*, one of each pair of feet.

Fig. 2. Superior antennæ.

Fig. 3. Posterior portion of body.

MICROSCOPIC ENTOMOSTRACA.

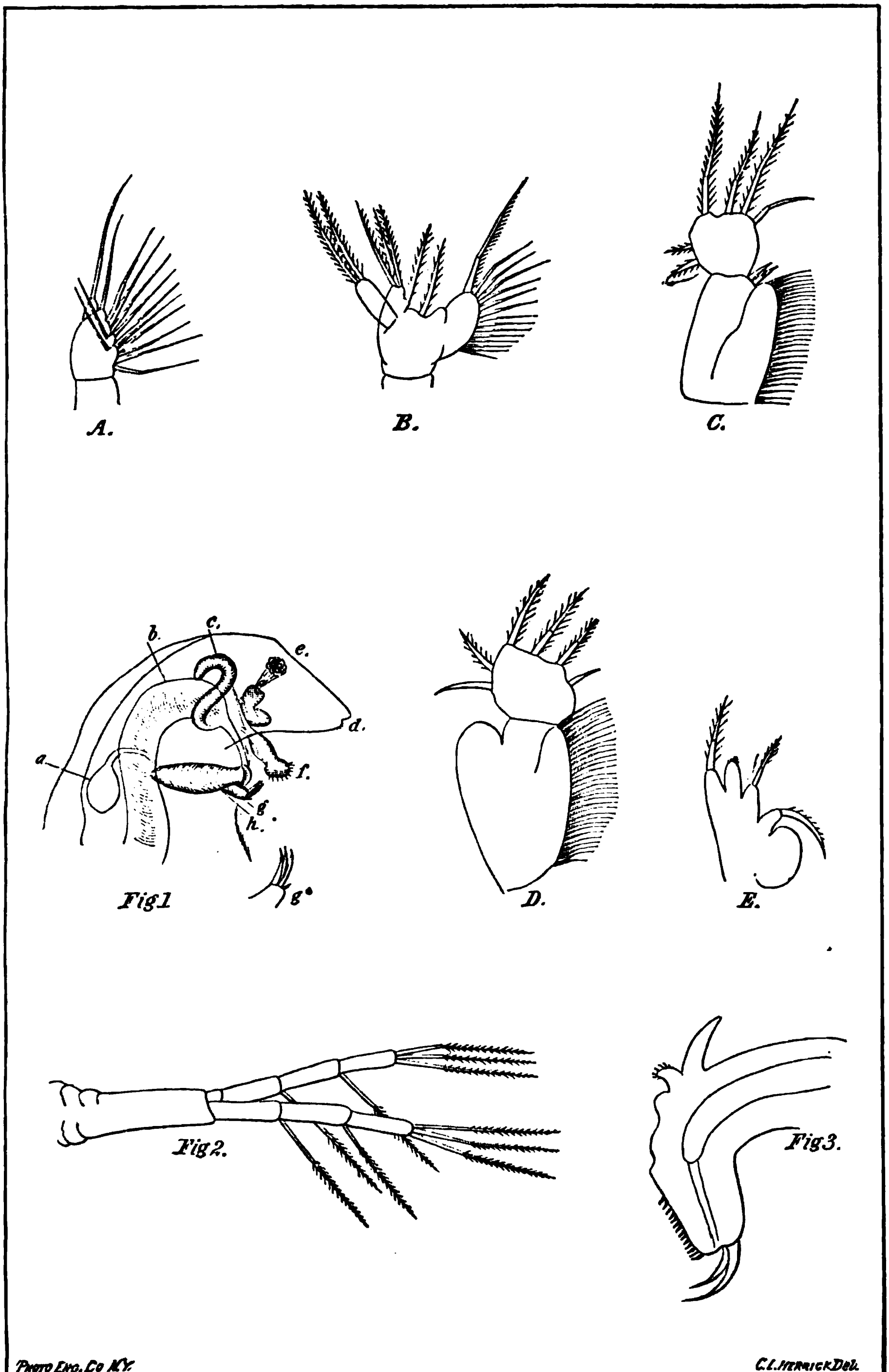


Plate IX.

PLATE X.

Daphnia vetula.—1, under view. 2, side view. 3, young extracted from egg. *a*, one of the setæ from the antennæ. *b*, jaw. *c*, base of the two rami of the superior antennæ. *d*, end of abdomen.

MICROSCOPIC ENTOMOSTRACA.

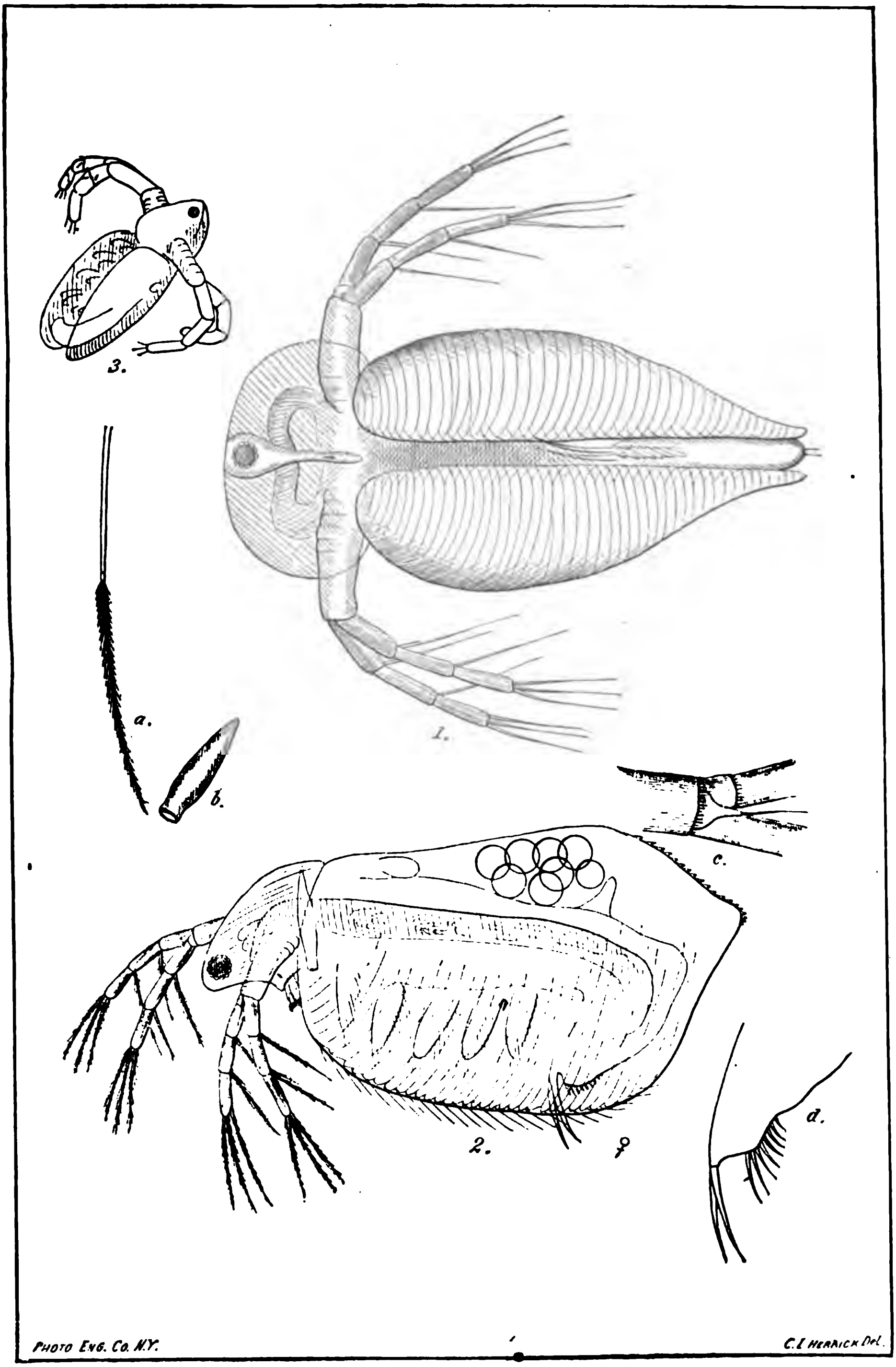


Plate X.

PLATE XI.

Daphnia vetula, male and female. *a*, jaws.

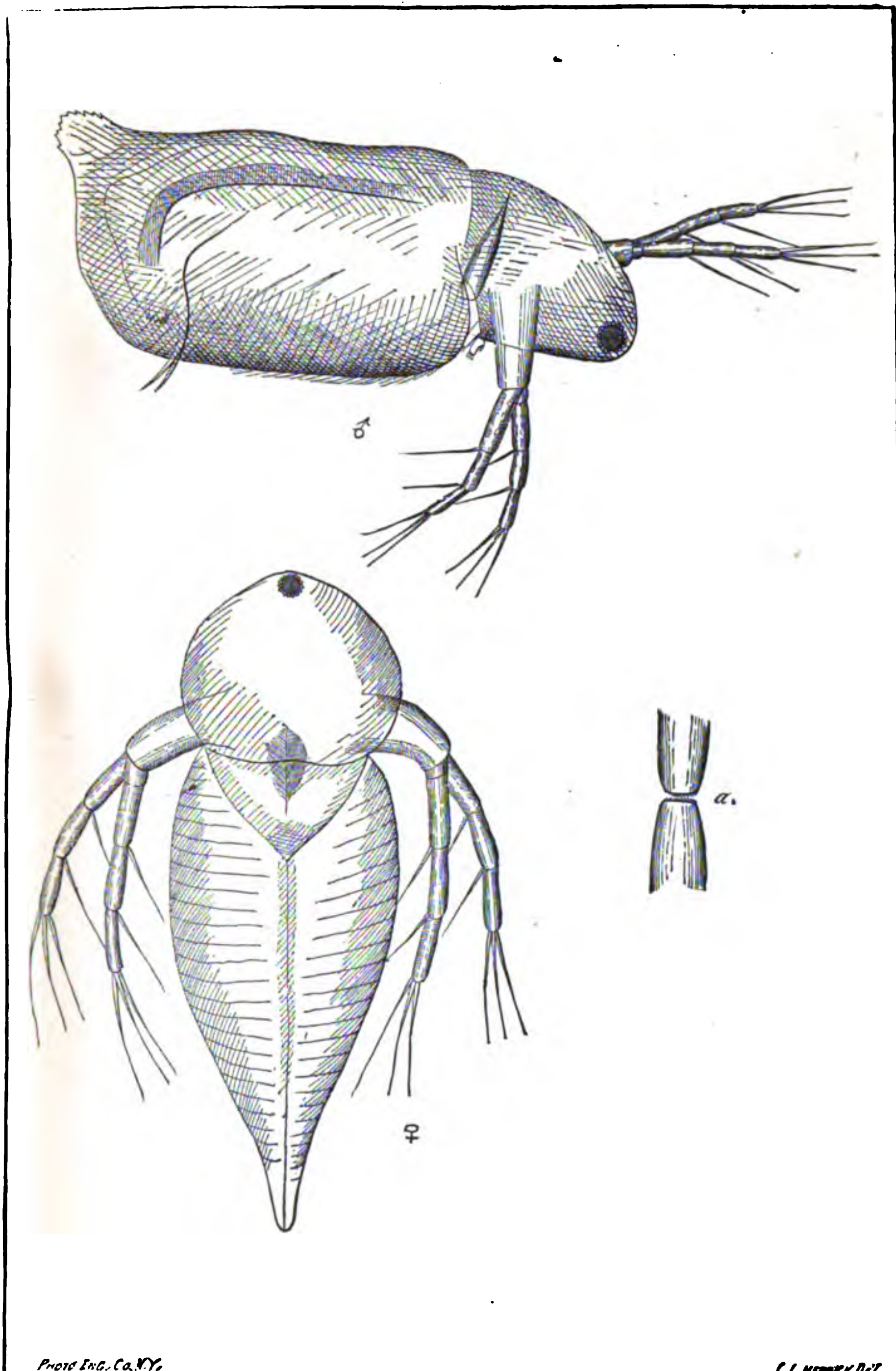


Plate XI.

PLATE XI.

Daphnia vetula, male and female. *a*, jaws.

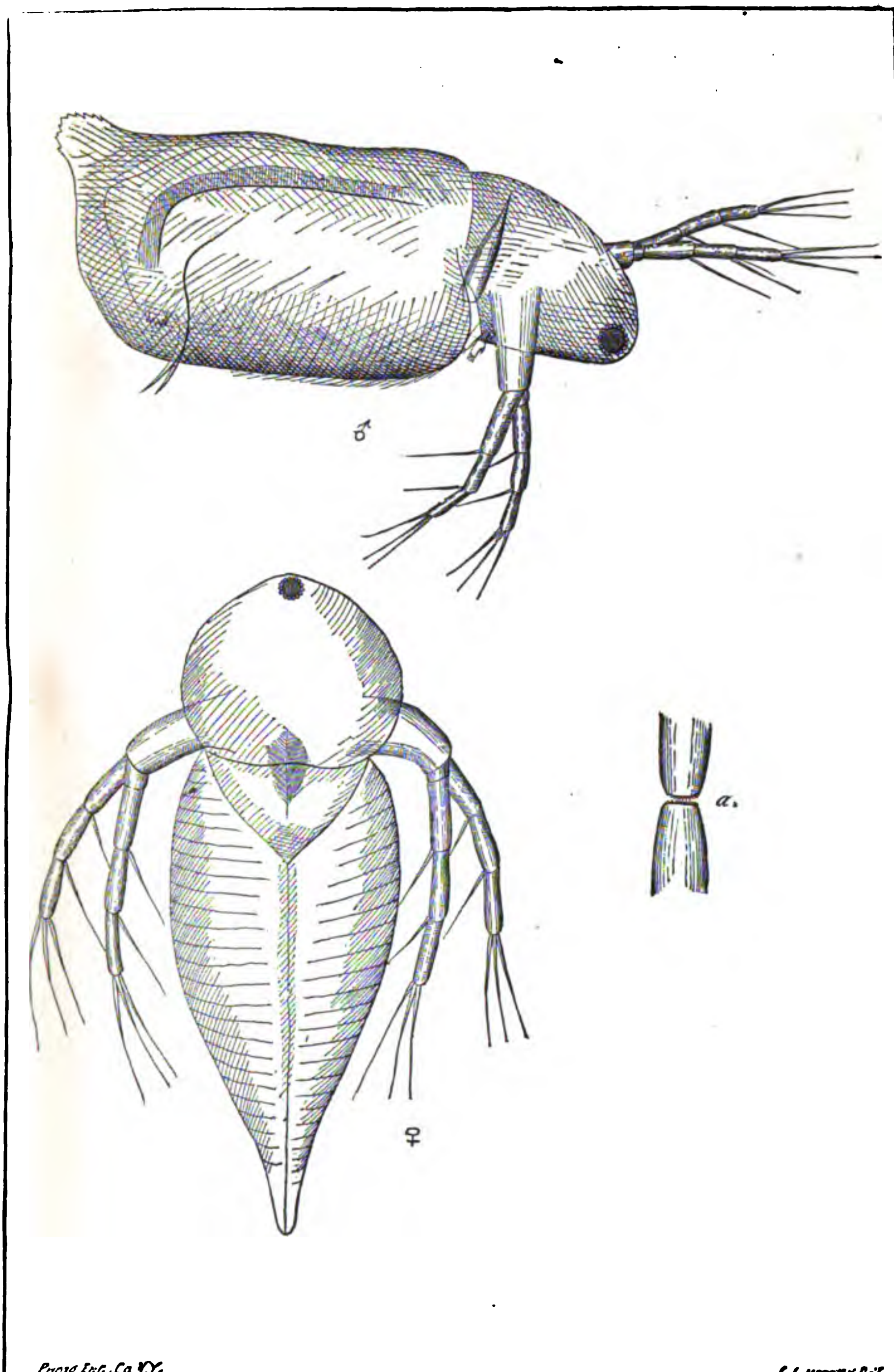


Plate XI.

PLATE XII.

Daphnia mucronata. **a, head and eye.**

MICROSCOPIC ENTOMOSTRACA.

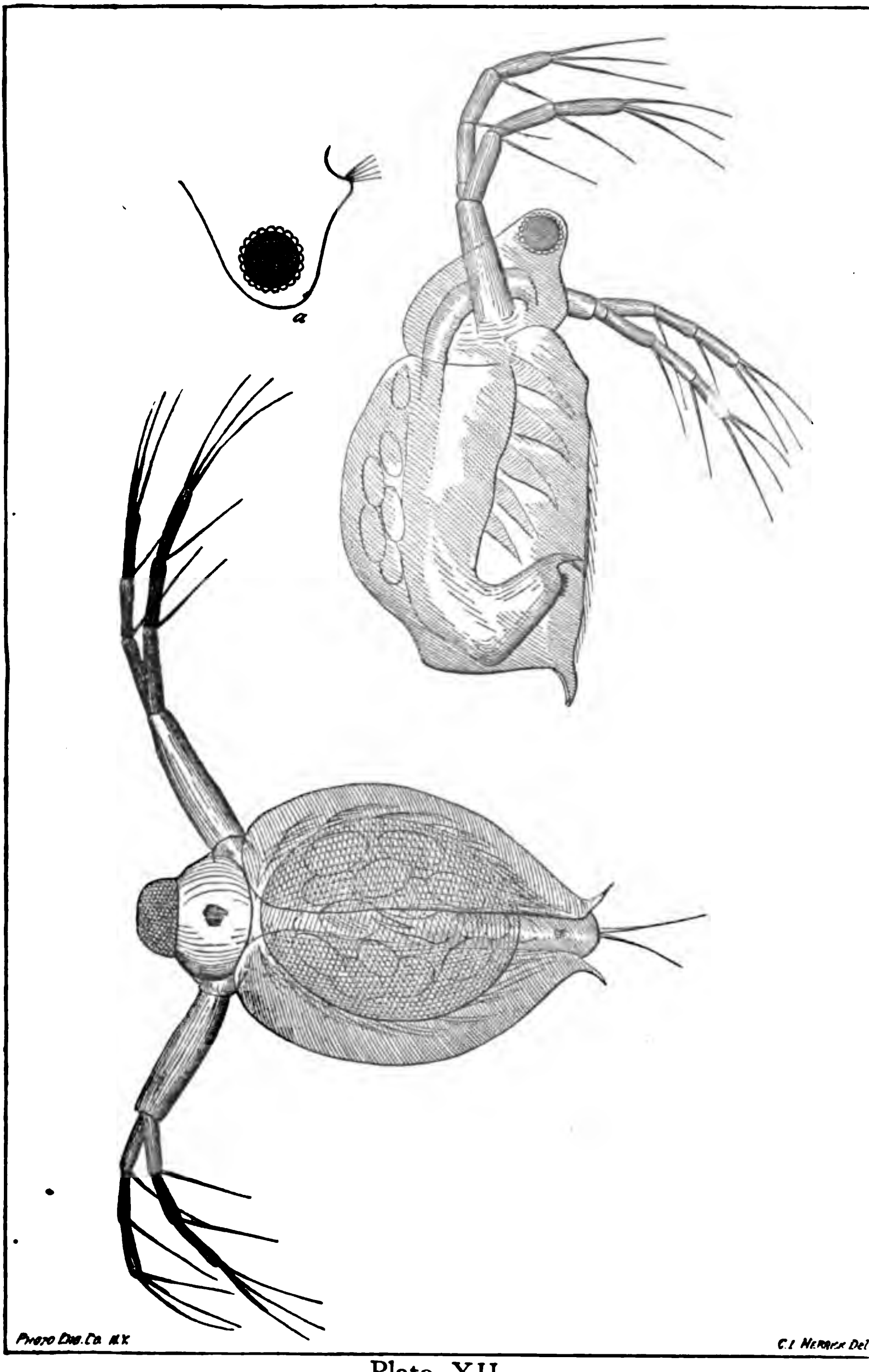


Plate XII.

PLATE XIII.

1, *Daphnia spinosa*, Herrick.

2, *Lynceus sp.* ?

3, *Lynceus sphæricus*.

MICROSCOPIC ENTOMOSTRACA.

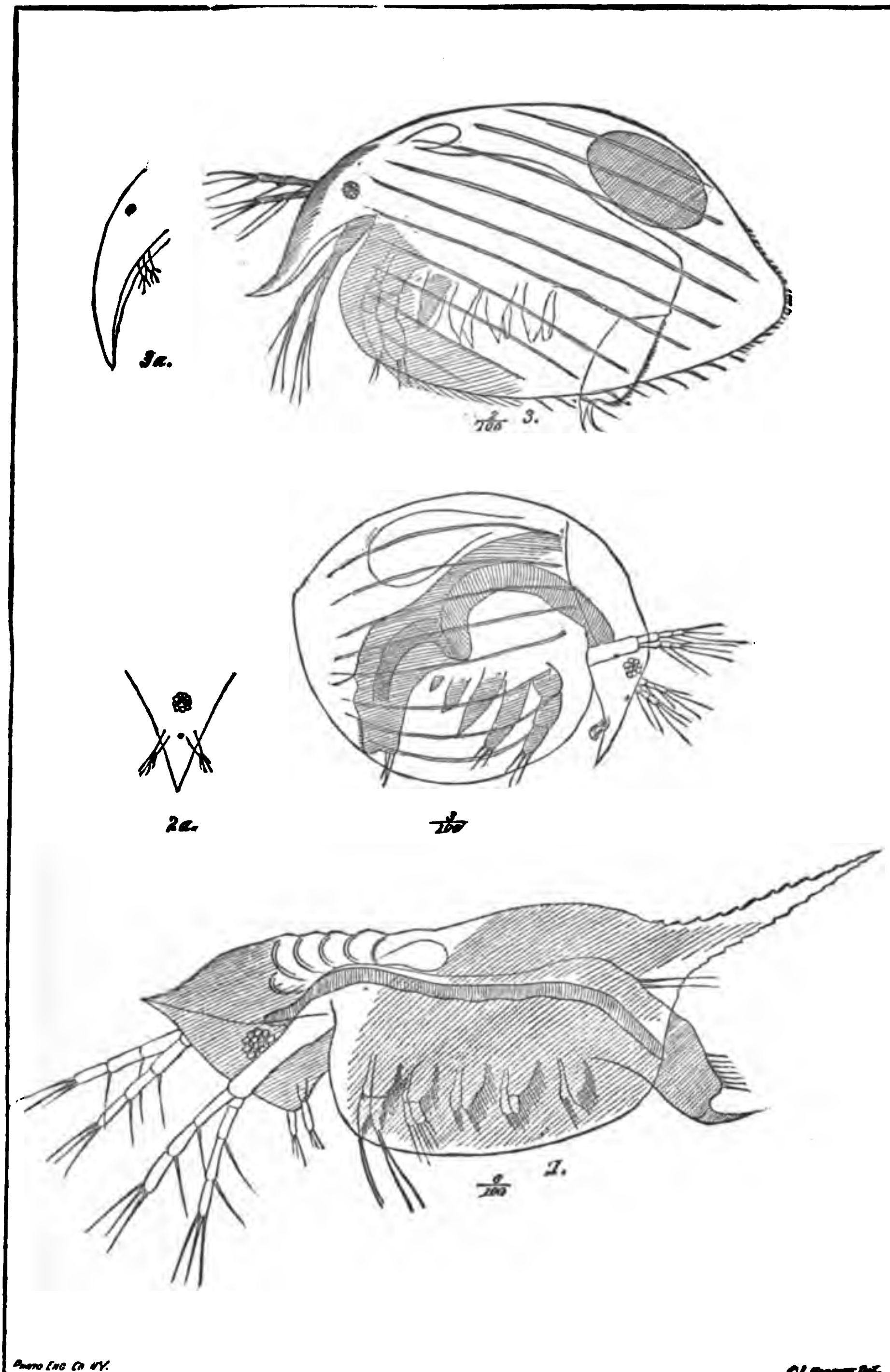


Plate XIII.

PLATE XIV.

Macrothrix agilis, Herrick. Two views. *a*, tail spine.

MICROSCOPIC ENTOMOSTRACA.

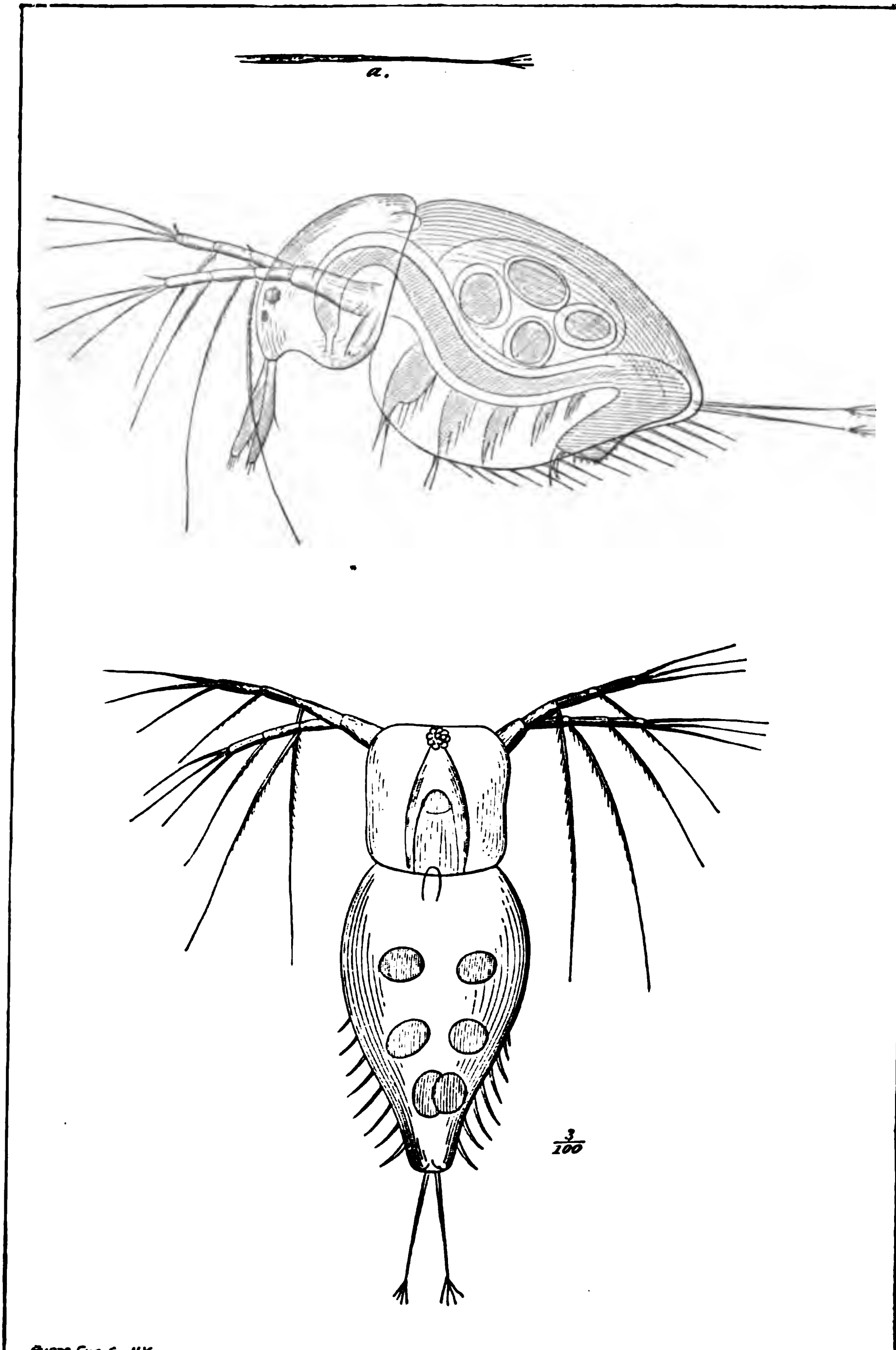


Plate XIV.

PLATE XV.

1, *Lynceus macrourus*, Muller. *a*, abdomen.

2, *Lynceus quadrangularis*, Muller.
a, beak. *b*, jaws. *c*, end of antennæ.

MICROSCOPIC ENTOMOSTRACA.

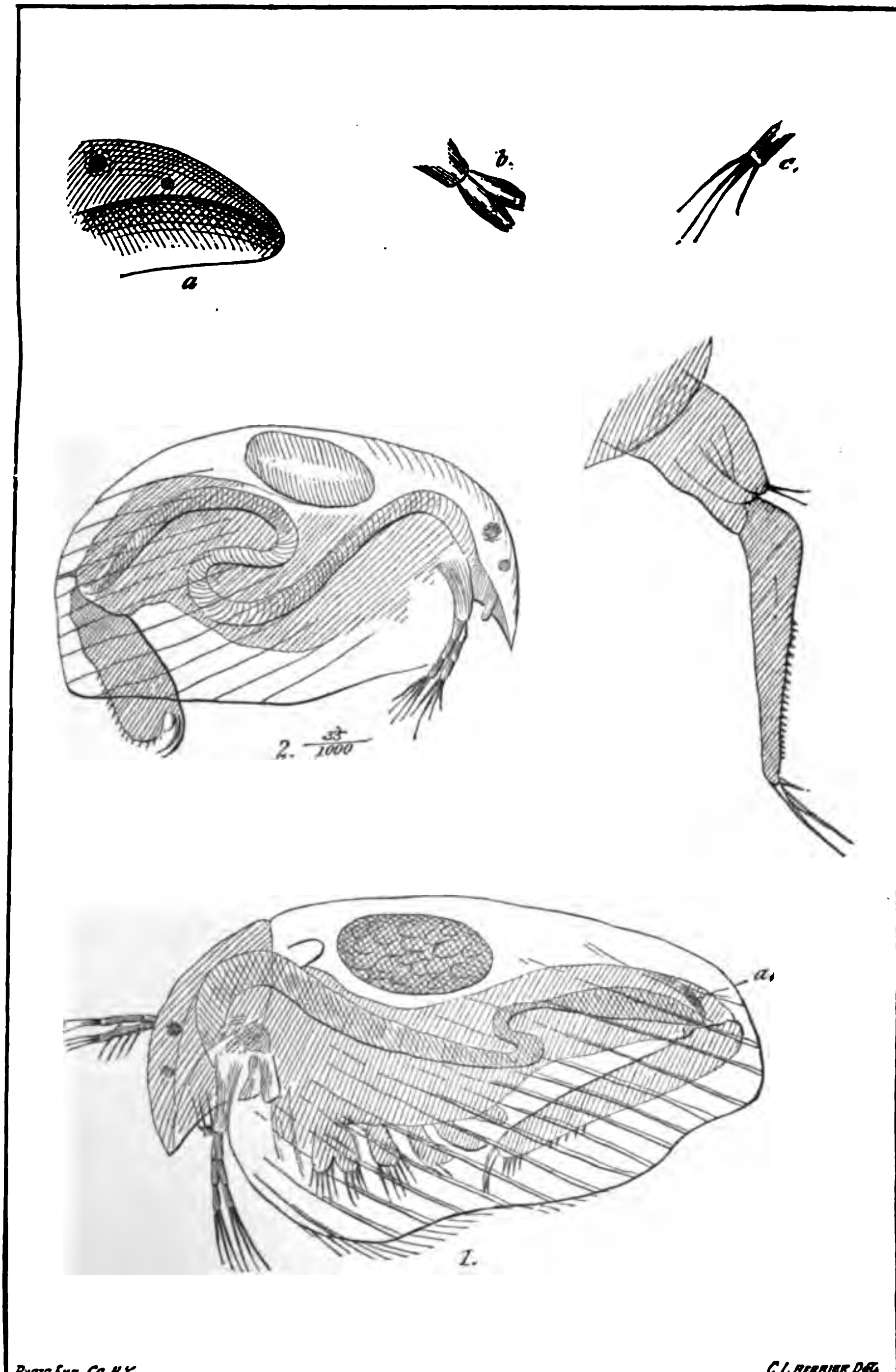


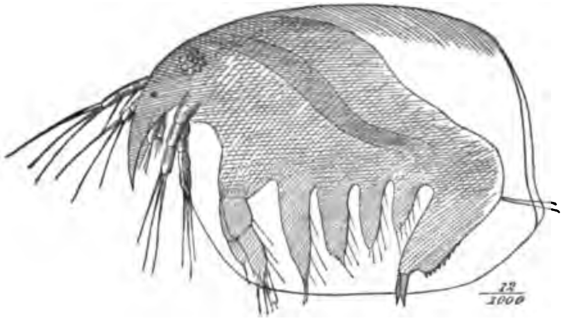
Plate XV.

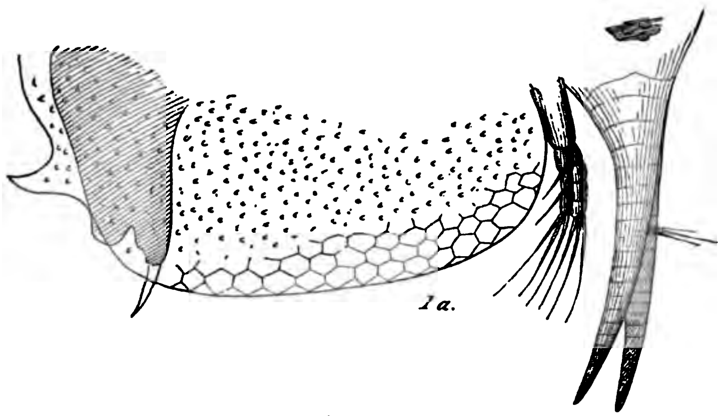
PLATE XVI.

1, Bosmina longirostris. *a*, portion of shell, superior antennæ.

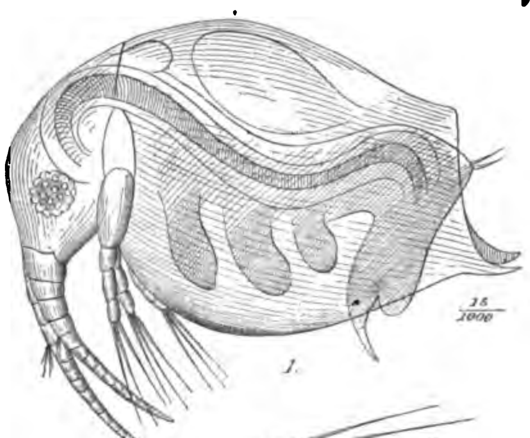
2, Lynceus sp. ?

MICROSCOPIC ENTOMOSTRACA.





1 a.



1.

1 b.

Photo Eng. Co. N.Y.

C L Herri

Plate XVI.

PLATE XVII.

1. ***Cypris vidua***, **Muller.**

1'. ——— ——— **top view.**

2. ***Cypris neglecta***, **Herrick.**
a, **testicle.** *b*, **maxilla.** *c*, **caudal stylets.** *d*, **inferior antennæ.**

MICROSCOPIC ENTOMOSTRACA.

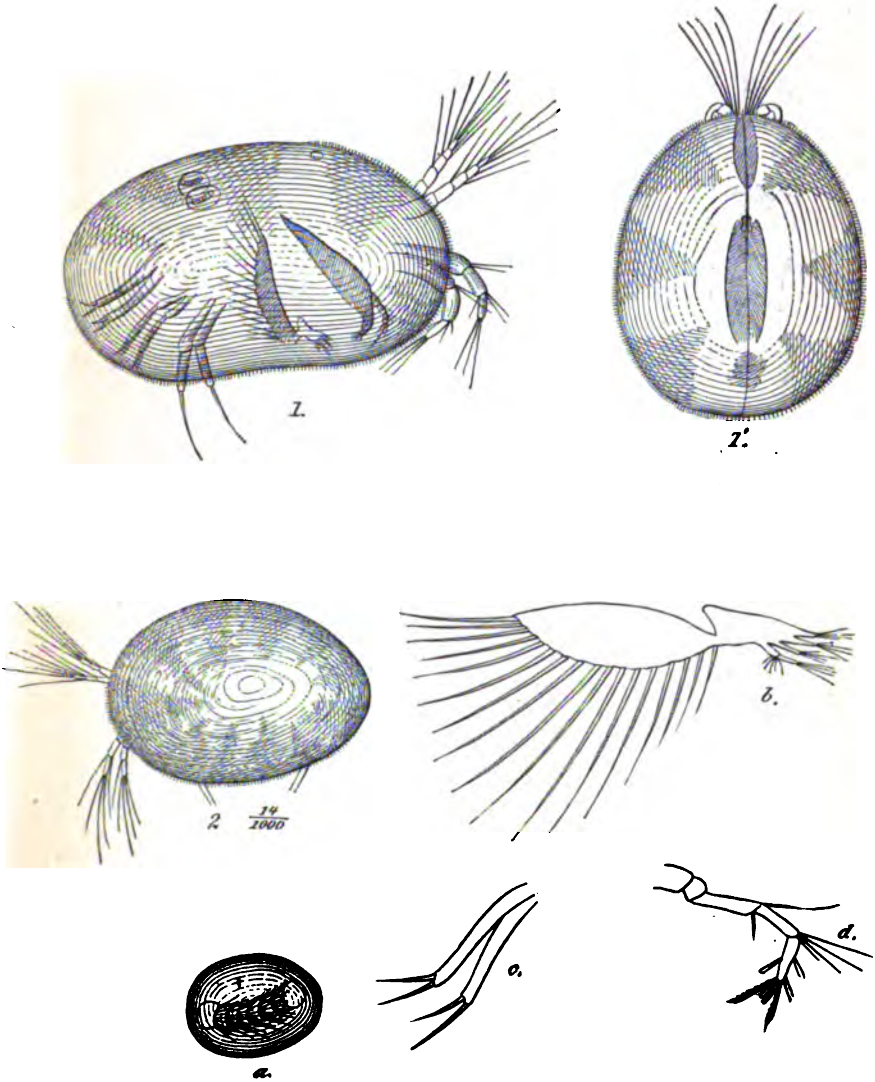


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Plate XVII.

PLATE XVIII.

Chirocephalus diaphanus. *a*, head of female. *b*, head of male with claspers removed. *c*, head of male. *d*, appendage of claspers.

MICROSCOPIC ENTOMOSTRACA.

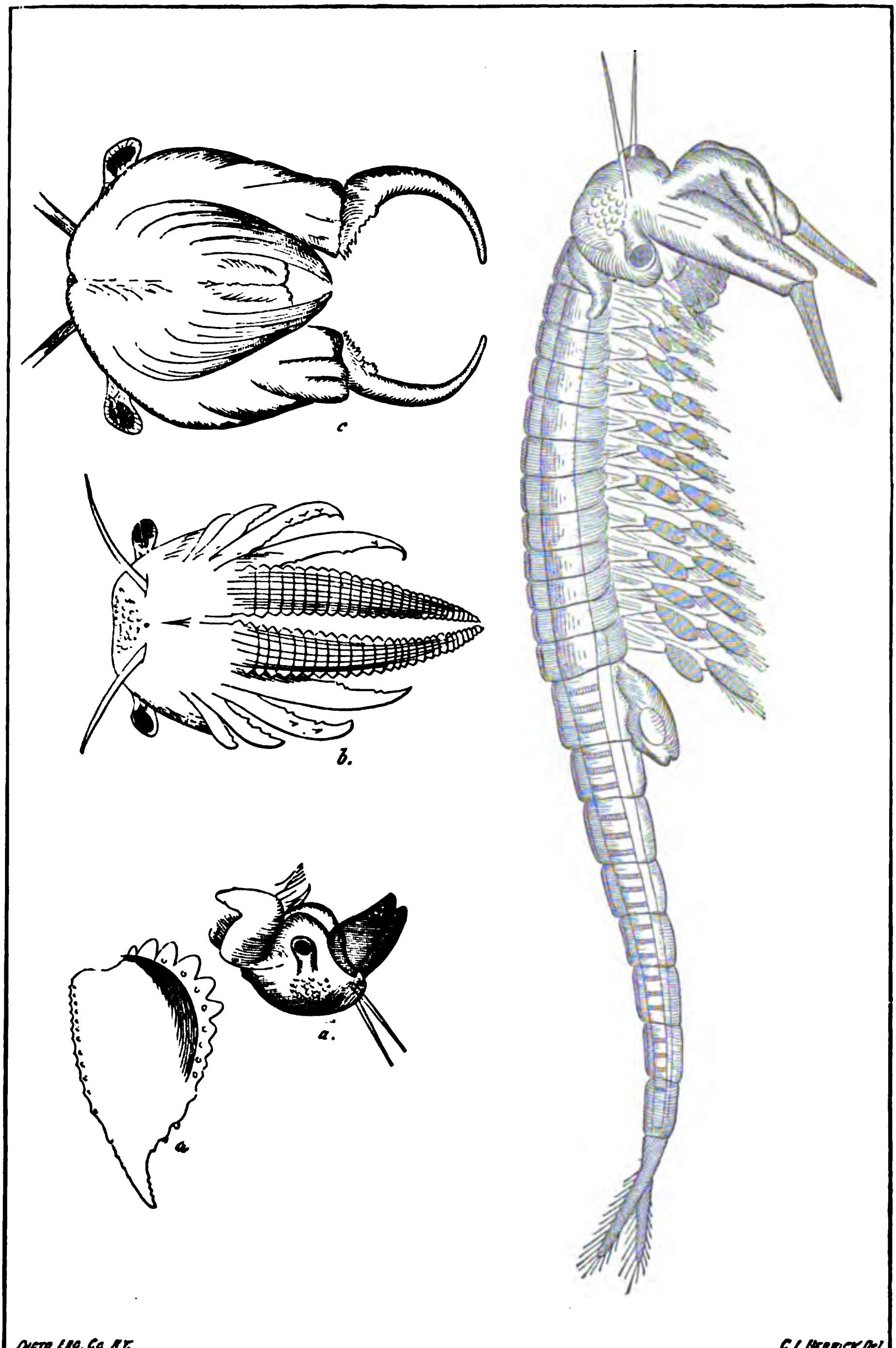

Plate XVIII.

PLATE XIX.

Nebalia, Streptocephalus, Artemia, Apus, Estheria and Limnetes.

MICROSCOPIC ENTOMOSTRACA.

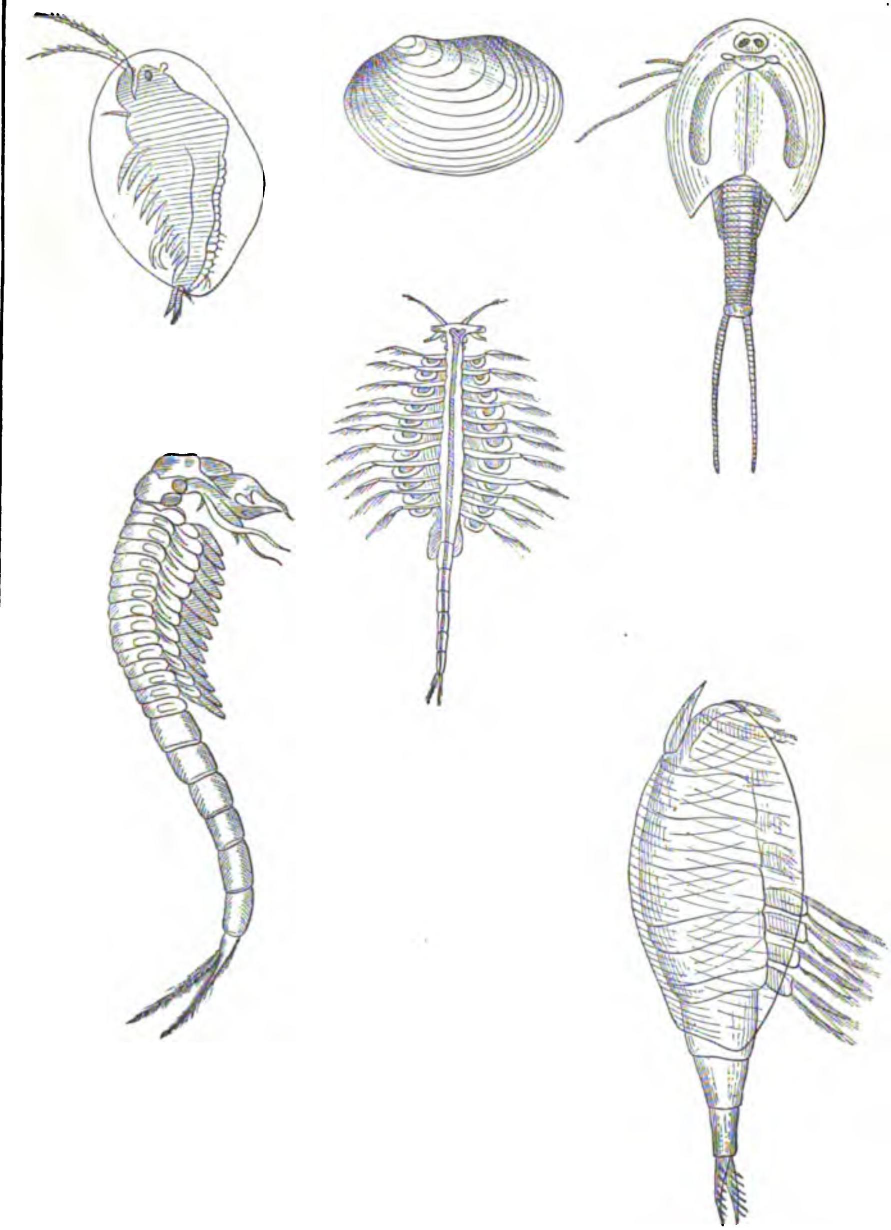

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Plate XIX.

PLATE XX.

1. Candona ornata. *2. Candona elongata.* 2*a*, testicle? 2*b*, maxillipeds.

MICROSCOPIC ENTOMOSTRACA.

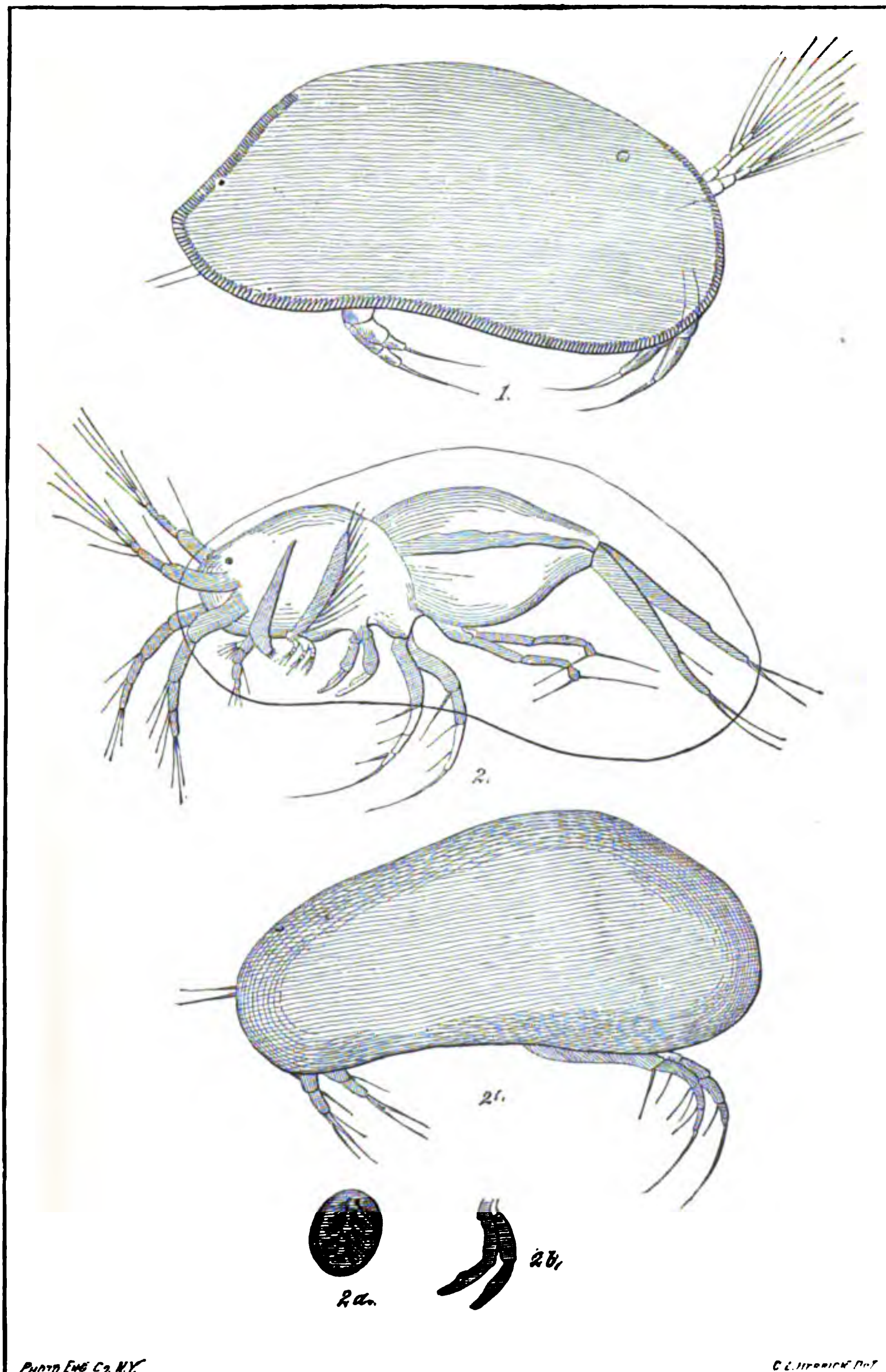

Plate XX.

PLATE XXI.

1. ***Daphnella Winchelli.*** **1*a* Embryo. 2. Side view of same.**

3. ***Polyphemus occidentalis.*** **3*a*, 1st pair of feet. 3*b*, 3d pair. *c*. jaw.**

4. ***Eurycercus lemellatus?*** **4*a*. foot. 4*b*. jaw.**

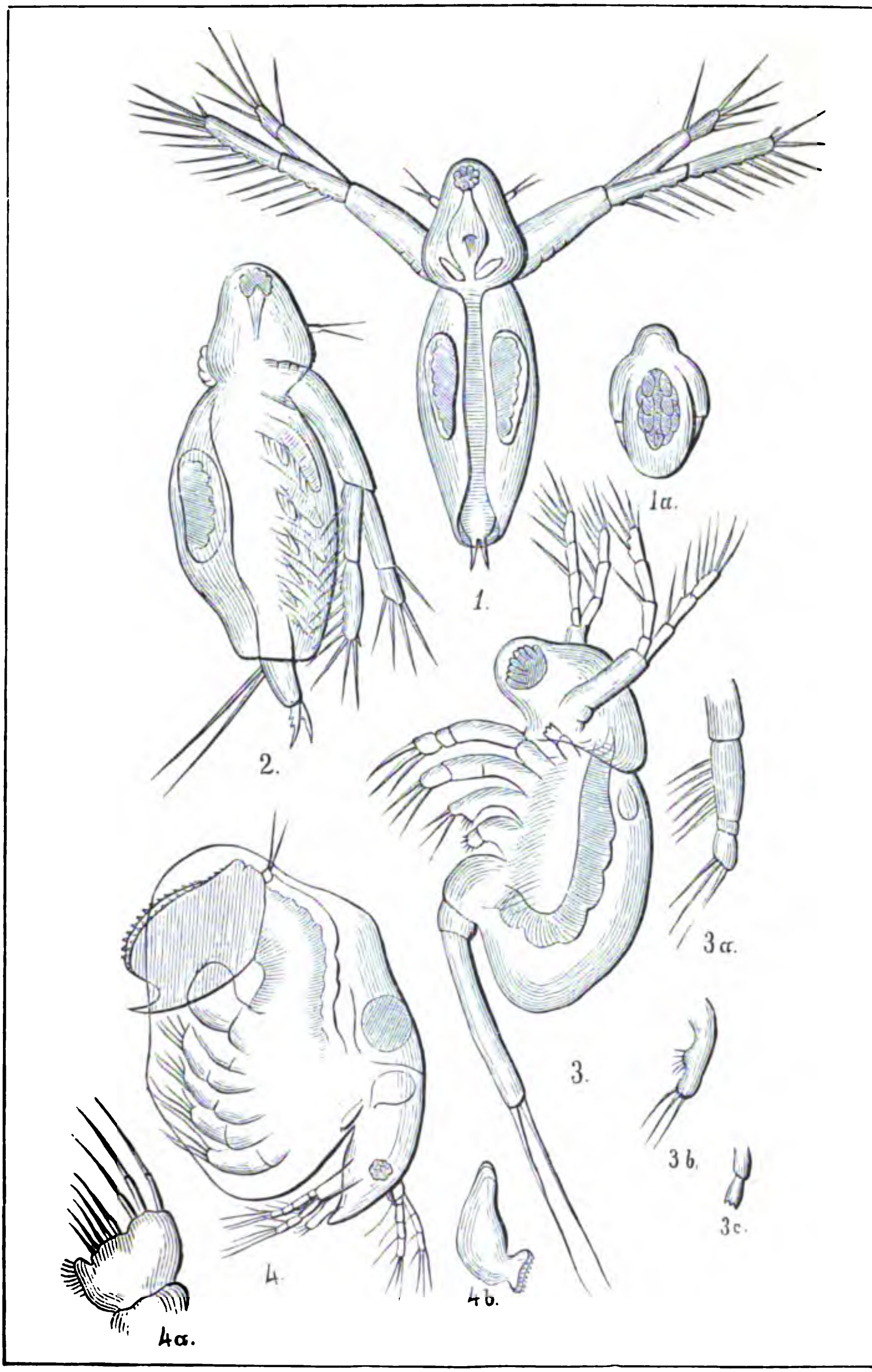

Plate XXI

INDEX TO THE GEOLOGICAL REPORT.

ERRATA.

The last line on page 13 should be transferred to be the sixth line on page 14.
On page 19, line 23, for *non-discovery* read *discovery*.
On page 119, 7th line from the bottom, for *neared* read *nearer*.
On page 24, last line, insert *they*.
At variouus places in the catalogue of specimens for *Linomite* read *Limonite*.

THE GEOLOGICAL

AND

NATURAL HISTORY SURVEY

OF

MINNESOTA.

THE EIGHTH ANNUAL REPORT.

FOR THE YEAR 1879.

Submitted to the President of the University, Feb. 18, 1880.

SAINT PAUL:
THE PIONEER PRESS COMPANY.
1880.


GEOL. & NATL. HIST. SURV
MINNESOTA.
Total area 83,531 Square miles.
MANITOBA
BRITISH POSSESSIONS
LAKE OF THE WOODS
RAINY LAKE
HUNTERS ISD.
ST. VINCENT
KITTSON
MARSHALL
POLK
RED LAKE
BELTRAM
ITASKA
ST. LOUIS
LAKE
COOK
LAKE SUPERIOR
CLAY
BECKER
CASS
WADENA
AITKIN
WILKIN
OTTERTAIL
TODD
MORISON
M. LELACS
KANABECK
PINE
GRANT
DOUGLAS
STEVENS
POPE
STEARNS
BENTON
SHERBURN
ISANTI
ANOKA
CHISAGO
TRAVERSE
BIG STONE
SWIFT
KANDYOHI
MEEKER
WRIGHT
HENNEPIN
RAMSEY
WASHINGTON
LAC QUI PAR E
CHIPPEWA
RENVILLE
MCLEOD
CARVER
SCOTT
DAKOTA
YELLOW MED.
SIBLEY
NICOLLET
LESUEUR
RICE
GOODHUE
LINCOLN
LYON
REDWOOD
BROWN
WABASHA
PIPE STONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
DAKOTA
IOWA
WISCONSIN
MISSISSIPPI
ST. PAUL
STILLWATER
DULUTH
SUPERIOR
L. PEPIN
W. WIS. R.R.
& GREEN BAY R.R.
N. PAC. R.R.
ST. CROIX R.
ST. LOUIS R.

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

ANNUAL REPORTS.

The First Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1872. *By N. H. Winchell.* 8*vo.* 112 *pp., with a colored geological map of the State. Published in the Regents' Report for* 1872. *Out of print.*

The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. *By N. H. Winchell and S. F. Peckham. Regents' Report;* 148 *pp.* 8*vo.; with illustrations.*

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. *By N. H. Winchell.* 41 *pp.* 8*vo., with two county maps. Published in the Regents' Report for* 1874.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. *By N. H. Winchell, assisted by M. W. Harrington.* 162 *pp.* 8*vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for* 1875.

The Fifth Annual Report on the Geological and Nataral History Survey of Minnesota, for the year 1876. *By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson:* 8*vo.* 248 *pp.; four colored maps and severa other illustrations. Also published in the Regents' Report for* 1876.

The Sixth Annual Report on the Geological and Natural History Survey, for the year 1877. *By N. H. Winchell, with Reports on Chemical Analyses by Prof. Peckham, on Ornithology by P. L. Hatch, on Entomology by Allen Whitman, and on the Geology of Rice County by L. B. Sperry; three geological maps and several other illustrations.* 226 *pp.* 8 *vo. Also published in the Regents' Report for* 1877.

The Seventh Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1878. *By N. H. Winchell, with a Field Report by C. W. Hall, chemical Analyses by S. F. Peckham, Ornithology by P. L. Hatch, a List of the Plants of the north shore of Lake Superior by B. Juni, and an Appendix by C. L. Herrick on the Microscopic Entomostraca of Minnesota, with twenty-one plates.* 123 *pp.* 8*vo. Also published in the Regents' Report for* 1878.

MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR No. 1. *A copy of the law ordering the survey, and a note asking co-operation by citizens and others.* 1872.

2. PEAT FOR DOMESTIC FUEL, 1874. *Edited by S. F. Peckham.*

3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. *A history of all official transactions relating to them, and a statement of their amount and location.* 1874. *By N. H. Winchell.*

4. A CATALOGUE OF THE PLANTS OF MINNESOTA; *prepared in* 1865 *by Dr. I. A. Lapham, contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in* 1875.

5. CIRCULAR No. 2. *Relating to Botany, and giving general directions for collecting information on the flora of the State.* 1876.

6. CIRCULAR No. 3. *The establishment and organization of the Museum.* 1877.

7. CIRCULAR No. 4. *Relating to duplicates in the Museum and exchanges.* 1878.

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
Feb. 18, 1880.

To the President of the University:

DEAR SIR—I herewith transmit the Eighth Report on the progress of the Geological and Natural History Survey of the State.

Very respectfully your obedient servant,

N. H. WINCHELL.

REPORT.

I.

SUMMARY STATEMENT.

The season's work was begun by the detailed examination of Goodhue county, and of a portion of Wabasha—occupying about six weeks. The field-work was then transferred to the northern part of the State, where a special survey was made of the valley of the St. Louis River from Fond du Lac to about three miles above Knife Falls, covering the region of the *Dalles* and the water-power of that stream, and extended to some of the contiguous country. It was in July and August that another visit was made to the various points on the Lake Superior shore, that were shown by the examinations of the preceding summer to possess special interest, between Duluth and Pigeon River. Many extra specimens were obtained, and additional observations were made. A number of photographs were obtained of points exhibiting peculiar or typical geological features. This trip was extended to Silver Islet and Isle Royale in the small boat belonging to the survey, for the purposes of comparative study and the gathering of specimens. In the fall two inland expeditions were made from Grand Marais,—one occupying about ten days, and the other about six weeks. These, with the interior explorations of last year, so far as they covered that part of the State, may be said to carry the surveyed area in the northeast part of the State as far west as to Poplar river, though there are some points on the upper waters of the Cascade river that will still have to be examined, lying east of the Poplar river, while also a considerable area west of the Poplar river has been examined sufficiently.

In addition to the foregoing, which has been the personal labor of the writer in the field, the survey has made steady—and in some cases rapid—progress in other directions during the year. Mr. Warren Upham, late of the New Hampshire Geological Sur-

vey, has been occupied nearly the whole season in studying the geology of the drift-covered counties in the central and western portions of the State, with special reference to the topography, glacial geology, and economic resources of those counties. With a horse and wagon he has traveled about 3,300 miles, and has in his note-books the necessary data for reporting in full on twenty-two counties, or an area of over sixteen thousand square miles.

Prof. C. W. Hall spent the summer vacation in making collections of animals and plants on the Minnesota shores of Lake Superior, in company with Mr. Thomas Roberts, a student of the University. A catalogue of species of birds noted by Mr. Roberts accompanies this report. This catalogue will be extended to cover species collected since the beginning of the survey, as opportunies have arisen.

Mr. C. L. Herrick has been mainly unengaged during the year, but in the fall he aided Mr. Hall in sundry work connected with the Museum.

Prof. Peckham's report on the analysis of iron ores from different points in the State accompanies this report, and Dr. P. L. Hatch makes an annual statement of progress in the ornithological section.

At different times during the season the field parties of the survey have been accompanied and aided by the following gentlemen, viz.: Prof. H. B. Wilson, of Red Wing; Prof. George Weitbrecht, St. Paul; Rev. C. M. Terry, Minneapolis; Prof. Jabez Brooks, of the University of Minnesota; and Messrs. A. P. and D. D. Brooks, students in the University.

A report on operations in the Museum accompanies this, giving a list of recorded additions to the specimens, and the exchange of duplicates.

The survey has again to acknowledge the generosity and courtesy of President John P. Ilsley, of the St. Paul and Duluth R. R., and Supt. Chas. F. Hatch, of the Minneapolis and St. Louis R. R., for free transportation on those roads respectively, for the various members of the survey, and to the Mayhew Brothers, of Grand Marais, for the use of a building for the headquarters of the different parties of the survey while at work in that part of the State.

The editions of the first, second and third annual reports of the survey have been for some years exhausted. They were very small. With the publication of the fourth report the edition was increased by act of the Legislature to 1,000 extra copies. There

are frequent inquiries for the first, second, and third reports by citizens of the State, and by parties from abroad. These requests cannot be complied with, but, so far as possible, all reasonable demands for the reports are supplied. With the continuation of the survey, and the publication of its results, the demand for the earlier reports constantly increases. It is suggested that the first three reports might be reprinted in one volume. The three reports together contain 300 pages.

II.

LITHOLOGY.

The State of Minnesota possesses the widest range of lithological features. Its rocks show nearly all the mineral changes that have characterized the strata of the crust of the earth, and nearly all the crystalline and non-crystalline conditions and variations (excepting the post cretaceous trachytes) that are to be found in the United States. Owing to this great range in their natural history, the study of the strata becomes one of great interest and value. This is true both in an economical sense and in a scienfic point of view. The mineral associations which are known to accompany the existence of the useful and precious metals, the importance of their complete elucidation by the most exact methods, and the need that these examinations shall supplement the field observations, alike demand of the survey the full and searching scrutiny which modern science can give, and which alone will subserve completely the object for which the survey was instituted.

A large amount of field observations have been made, and many specimens have been gathered, the outward appearances of the formations have been carefully noted down in the field books, and annual reports of progress have dealt largely with these outward aspects. In view of the contemplated publication of the final volumes of the survey, it becomes necessary to devote a portion of the time available to the laboratory work necessary for these nicer investigations. The fossils of the sedimentary formations, the Silurian, Devonian and Cretaceous, must be named and catalogued, and the mineral composition of our crystalline rocks in the nothern part of the State must be ascertained. The methods of paleontological study are familiar to the geologists of the United States, and are well known to the people by the publication of numerous fine volumes by the State Governments, and by the United States; but the determination of the crystalline composition of the older, non-fossiliferous rocks, by the most exact and the most direct methods, is a science which is of recent birth.

The provisional determination of the minerals constituting a rock in the field, by the use of the pen-knife and the pocket lens, is often found to be erroneous when they are subjected to more careful examination. Indeed the minuteness of the various grains is often such that they cannot be separated from the mass even for individual chemical analysis, or blow-pipe examination. The only recourse was to perform an analysis of the rock in mass. This gives the aggregate amount of the various elements, as calcium, aluminum, iron, etc., but the manner in which these are combined, or what minerals they form, is still wholly conjectural. It is to the microscope we are indebted for the means of ascertaining the mineral composition of rocks, however fine, or to whatsoever extent they may have been changed by natural causes. Indeed, great changes in the rocky structure of the earth, long discussed with vague uncertainty, are fully explained by the microscopic phenomena of their mineral contents. It is proposed to give a brief resume of the methods of microscopic lithology, as an introduction to the results of the work that is now being carried on in the laboratory of the survey, and for preparing the way to the more advanced statements of the final report. These methods are applicable especially to the crystalline rocks—such as, having been once in a sedimentary condition, have been heated, pressed, dissolved, and then recompounded by crystallization, according to the laws of chemical affinity into mineral species, such as the feldspars or hornblendes. They apply with special value to the rocks known as Igneous, as these, on cooling from a molten condition always crystallize, unless the process be sudden, when they take on the glassy state or become amorphous slags. A large part of the State of Minnesota is occupied by rocks of this kind, while a still larger part is occupied by strata, which, although not igneous, are yet in that perfectly crystalline condition that shows they have been metamorphosed from a former sedimentary condition, and the distribution of the various elements composing them has been wholly remodeled since their formation.

The apparatus necessary for the microscopic examination of crystalline rocks is quite simple. Any method can be pursued to grind a fragment of the rock to be examined to a thin slice; so thin that light easily passes through it. It may be done wholly by hand, but in the laboratory of the survey is one of Prof. A. A. Julien's "lithologist's lathes," which is quite similar to a lapidary's, having leaden and iron laps, rotating horizontally on which the fragment is to be held by the fingers and ground with coarse

emery and water. The city water works of Minneapolis carry a pressure into the University which has an average of about twenty-five pounds, and this pressure is used to run the lathe by the use of one of Tuerk's hydraulic motors. The fragment is first ground to a smooth and even surface on one side by holding it with the fingers on the rotating leaden lap with moderately coarse emery and water. It is then changed to the iron lap, with fine emery powder for smoothing the same surface: and lastly, is polished by hand with "emery shine" on a piece of plate glass. This smoothed surface is then washed entirely clean and is firmly cemented by Canada balsam to a small piece of plate glass about an inch and a half square. The process of attaching it to the glass plate is performed by gently warming and melting a little hard Canada balsam lying on the glass plate over a spirit lamp. In order that all smoke may be kept from the plate, and that the glass may heat evenly, it is laid on a thin iron plate, which is held or supported by tripod, over the lamp. When the balsam is thoroughly liquified, without boiling, the smoothed surface of the ground fragment (itself also warmed by lying on the iron plate) is pressed into the balsam and firmly held down on the glass till the balsam cools and hardens. No bubbles of air must be allowed to remain between the fragment and the glass plate. The other side of the fragment is now applied to the leaden lap and ground, as before, till it is thin enough to begin to transmit light, when it is finished by grinding with the fine emery on the iron lap, and rendered perfectly smooth with the emery shine by careful rubbing by hand on the glass plate. When it is finished it is so thin that it is wholly transparent, and its edge, lying on the glass plate, is hardly visible to the eye. The piece of plate glass, after thorough washing and drying, is again warmed on the iron plate, with a small fragment of hard balsam lying on the section. At the same time another fragment of hard balsam is warmed in the same way, and melted on a common microscopic glass slide, the best size of which is 45x25 mm. When the thin section is loosened by the melting of the balsam, and the fragment lying on it is liquified, a thin glass cover is placed on the section, and the section and cover, adhering together, are gently pushed off the glass plate on to the liquid balsam lying on the warmed glass slide in such a way that the section shall be embraced between the slide and the cover. By gently moving the cover, and pressing it down, all air bubbles are excluded, and it is brought as nearly in contact with the slide as is possible, with the thin section near the center of the slide. When it is sufficiently cooled,

and the balsam is hardened, the superfluous balsam is removed with a warmed pen-knife, or dissolved away with a drop of alcohol. The thin section, when cleaned again and wiped dry with a cloth, is ready for examination.

The microscope necessary for this use is not yet made in this country. Several styles are made in Europe, particularly the stauroscopic microscope of Rosenbusch, and that of Watson, recommended by Mr. Rutley in his recent work, "The Study of Rocks," published in London. But a common microscope of any style can be easily changed, and the necessary attachments furnished, in this country. The Tolles microscope, belonging to the survey, was altered in New York by Prof. A. A. Julien, and by his direction was supplied with the necessary accessories. The stage must rotate on an axis which is the same as the line of vision through the body of the microscope, and the edge of the rotating stage must have a graduated scale for determining the degrees of rotation. Below the stage is placed a Nicol prism for polarizing the ray of light that enters the microscope, and above the ocular is another for analyzing it on its emission. These are both provided with graduated rims, so that on their rotation the degrees of change can be quickly read off. They are each also easily removable. In the eye-piece (A) are crossed spider-lines, so that the planes of vibration of the polarized light can be accurately adjusted in relation to any angle, or any line of a crystal that may be placed on the stage. It is also necessary to have an accurate "centering" instrument, *i. e.*, a nose-piece, adjustable in the lower end of the tube of the microscope, by which the line of vision in the center of the field can be made to coincide exactly with the axis of revolution of the stage. Mr. Rosenbusch's microscope has centering screws that move the body of the microscope itself.

As minerals are produced by the combination of the elements (as iron, silicon, calcium) so the crystalline rocks are produced by the combination of minerals. The elements, however, combine with mathematical precision, and in accordance with definite chemical affinities, but the compounding of the minerals with each other to constitute the crystalline rocks, is very various and heterogeneous. A mineral species is definitely known and describable, but the rock compounds shade into each other, and can be subjected to only a general and broad system of nomenclature.

The geometrical forms of crystals are so constant, that all minerals having a crystalline structure are referable to some of the six systems of mineralogy. These are fully described and illus-

trated in the usual text-books and manuals of Mineralogy, of which the chief in the English language, perhaps, are those of Dana.* These systems are as follows :—

ISOMETRIC.
TETRAGONAL.
HEXAGONAL.
ORTHORHOMBIC.
MONOCLINIC.
TRICLINIC.

These have different optical characters in polarized light. *Amorphous*, or non-crystalline substances, like glass, do not polarize light, nor affect its nature after polarization. They simply refract it, or divert it from its original direction. The interior particles of crystals are arranged in lines and planes, having fixed relations to the axes of the crystals, and when a ray of light enters among these particles it is propagated, or interrupted, or modified, according to the ease with which its waves can move among these planes, and hence emerges a *polarized* ray. The simple polarization of light does not affect its appearance to the eye, except to dim its brightness. Hence when the polarizer only, which consists of a piece of a crystal of Iceland spar, is placed below the stage of the microscope, the field still appears light, although a part of its waves were cut off by the polarizer; but when the analyzer, which is another crystal of Iceland spar, is also placed over the eye-piece of the microscope in such a way that its position is at right angles to that of the polarizer, the light is wholly interrupted and the field is dark. In the case of *isometric* crystals the axes are all of equal length, and their planes all interfere with the ray of light equally. Hence its waves are not separated nor differently retarded, and they emerge from such crystals without polarization. Amorphous and isometric substances are thus simply refractive, or "single-refracting," and are called isotropic.

In the case of *tetragonal* crystals the axes are not all of the same length, and the waves of light on entering such a crystal are propagated with greatest ease in the direction of its longest axis. The vertical axis, which is perpendicular to the lateral axes, may be the longest, or it may be the shortest. The two lateral axes are equal, and they do not differ in the ease with which they transmit the waves of light. Hence a beam of light, on emerging

*System of Mineralogy. 1868. Text-Book of Minerology. 1877.

from a tetragonal crystal, or a thin section of the same,* is separated into two sets of waves, or in other words, each wave is divided into two parts, one in advance of the other, and each set has the properties of polarized light. These sets advance parallel to each other, but the vibrations of the waves of the two sets are at right angels to one another. In the Nicol prisms one of these sets, known as the "ordinary ray," is so far diverted from its course before it leaves the prism that by an artificial combination of the parts of the prism it is wholly reflected and destroyed against the blackened sides of the prism. This leaves only one set of vibrations to pass through the prism, and they emerge a completely polarized ray. If a beam of light from the lower Nicol passes through a thin section of a tetragonal crystal in a direction parallel to the vertical axis, it is affected by the crystal equally in all directions, because the lateral axes, being equal and arranged symetrically about the vertical axis, allow the waves to pass in the same manner as an isotropic substance. If such a section be placed on the stage of the microscope and at the same time the upper and lower Nicol prisms are placed so that their planes of polarization are crossed, the light from the lower Nicol passes unmodified through the section, but is intercepted by the upper Nicol, and the field of the microscope is dark. If the Nicols are made parallel; the ray passes through, and the field is light. On the other hand, if a beam of light from the lower Nicol is allowed to fall upon a thin section of a tetragonal crystal in a direction perpendicular to the vertical axis, it meets with different resistance in different directions, at right angles to each other, and is at once divided into two sets of vibrations. One set is parallel to the vertical axis, and the other is perpendicular to it. If, however, the direction of the vibration of the waves from the lower Nicol exactly coincides with the direction of the vertical axis in the thin section, the waves are not thus divided, but pass through the section unmodified. This is also the case if it coincides with the direction of the lateral axis, or is perpendicular to the vertical axis. Hence, if the Nicols are crossed, such a section, on being rotated between them on the stage, will be *colored*, by the interference of its transmitted light, in all positions except when the axes coincide with the directions of the Nicols, in which cases the light from the lower Nicol, being allowed to pass unmodified, is intercepted by the upper Nicol, and the field is dark. This occurs four times in making a complete revolution of the stage. If the Nicols are

* Except it be cut perpendicular to the vertical axis.

parallel, there will be four positions, removed 90° from each other, in which the section will be light, instead of dark, and in all other positions it will be colored.

In the case of *hexagonal* crystals, as their axes are situated with respect to each other exactly like those of tetragonal, *i. e.*, each perpendicular to the other two, and the vertical longer or shorter than the lateral, which are equal to each other, their optical characters are the same as those of tetragonal. They can be distinguished by the forms of their sections, cut perpendicular to the vertical axis. Tetragonal crystals thus cut have four or eight sides, but hexagonal have six, or some other multiple of three. Hexagonal and tetragonal crystals are called uniaxial, because there is but one axis in the direction of which they act as isotropic substances. It is that of the crystallographic vertical axis.

When tetragonal or hexagonal crystals are examined in convergent polarized light, a basal section shows, at crossed Nicols, a series of rings of color and a dark cross. This convergent light is usually obtained by special apparatus; but Mr. Geo. W. Hawes describes a method of examining crystals which have some considerable size, in convergent light in the common microscope,* when the analyzer is placed above the ocular. By removing the ocular and replacing the analyzer, the field of view is made small, and the magnifying power of the instrument is destroyed; but the peculiar ring system and the cross bars are distinctly visible in many basal sections of such crystals.

Mineral crystals belonging to the *Orthorhombic* system have three axes at right angles to each other, but they are all of different lengths. Light, in passing through such a crystal finds three directions, one of greatest ease, one of least, and one which is the mean of these. Hence, when a ray enters a thin section cut in any direction, it is doubly refracted and separated into two sets of waves having their vibrations at right angles to each other. One set vibrates in the direction of the greatest ease of movement, and the other in the direction of the least, and these correspond with two of the crystallographic axes. When a thin section of one of these crystals is brought between the Nicols, when they are crossed, it is colored in all positions, except when the direction of a crystallographic axis coincides with the plane of vibration of the light, when it will be dark. This occurs at four different places in the rotation of the stage, and they are separated from each other ninety degrees. Orthorhombic

*Mineralogy and Lithology of New Hampshire. Geol. Survey, Part IV. 1878.

crystals, moreover, are isotropic, *i. e.*, remain dark between crossed Nicols during an entire revolution of the stage, in two directions, and for this reason they are called biaxial. These directions, or optical axes, are in the plane of the greatest and least ease of movement of light, and make equal angles on opposite sides of the axes of least elasticity. If a section cut perpendicular to one of these optical axes be examined in convergent light, in the same manner as already mentioned with uniaxial minerals, the field will be colored by a series of rings, and a single dark bar will be seen crossing the field, which will revolve on the rotating stage in the direction opposite to that in which the stage is revolved.

Minerals belonging to the *monoclinic* system have three axes for the movement of light, as in orthorhombic crystals; but these do not correspond with the crystallographic axes. One of them corresponds with the orthodiagonal axis, and the others are at right angles to this axis and to each other, and lie in the plane that includes both the vertical and the clinodiagonal axes, and parallel to the clinopinacoid faces. Hence, in many respects the optical characters of monoclinic crystals are like those of orthorhombic. If the two rectangular axes of light-movement in any thin section coincide with the axes of the two Nicols, crossed, the field of the microscope remains dark, but in all other positions it is colored. Sections parallel to the base, or to orthopinacoid faces, answer these conditions. Sections parallel to the clinopinacoid face are employed to determine the angle between one of the axes of elasticity and the clinodiagonal axis. This is done by aligning the edges or the cleavages of the section with the spider lines in the ocular so that the vertical axis coincides in direction with the plane of vibration of light from the lower Nicol. In this position the field is colored, although the Nicols are crossed, showing that the vertical axis does not coincide with the axis of light-movement. By rotating the thin section on the stage, between crossed Nicols, the field soon becomes dark, which implies that an axis of light-movement coincides with the plane of polarized light from the lower Nicol. The angle through which the section was rotated is the angle between the vertical axis and the axis of light-movement. By rotating it still further, the field becomes colored and then dark again at 90° from the point at which it was last dark, which implies that another axis of light-movement, at right angles to the last, coincides in direction with the plane of vibration from the lower Nicol prism. If a thin section be made parallel to the base, or the orthopinacoid, it will contain the orthodiagonal axis and the vertical axis, which are at right angles to each other. As

2

the orthodiagonal is also an axis of light-movement, the plane of vibration from the lower Nicol will coincide with it, and the effect will be the same as in a similar section of an orthorhombic crystal, viz.: the field will remain dark at crossed Nicols when these axes are brought into coincidence. In monoclinic crystals, moreover, there are two optic axes, that is, directions in which, if a thin section be cut, the effect in polarized light is the same as produced by an isotropic body, and these axes coincide with the directions of the greatest and least ease of light-movement. The interference figures produced by examining, in converging light, a thin section of a monoclinic crystal, cut perpendicular to these optic axes, are the same as seen in similar sections of orthorhombic crystals, and these axes can be determined by such examination of the different elasticity axes in succession in sections cut perpendicular to the same.

In *triclinic* crystals there is an entire want of conformity between the crystallographic axes and the directions of light-movement. While the former are all inclined to each other, the latter are all perpendicular to each other. Hence, when the vibration plane of the lower Nicol corresponds with the direction of any of the crystallographic axes, a thin section between crossed Nicols will never be dark, but must be rotated to become so, the amount of rotation being entirely arbitrary, but dependent on the species of the mineral and the direction of the section. They also have two optic axes, round which the arrangement of lines and planes in the crystal is such as to act symmetrically on a ray of light in all directions, and hence to produce the same effect as isotropic substances.

Circular Polarization is that effect on a ray of light which is produced by some uniaxial crystals when it passes through a section cut perpendicular to the vertical axis. The ray, instead of being polarized at right angles, is circularly polarized; that is, its waves of different lengths, as blue, or yellow, or red, are retarded unequally, and between crossed Nicols any one of these colors can be intercepted by rotating the analyzer a little, according to the thickness of the plate, so as to show a field wholly of one color. This is taken advantage of in the examination of monoclinic and triclinic crystals, in order to determine the angle between the axis of light-movement and the axis of the crystal more accurately than can be done by simply noting the point of greatest extinction of light, as already described under monoclinic crystals. If a quartz plate $3\frac{3}{4}$ mm. in thickness, cut perpendicular to the vertical axis, be placed between crossed Nicols directly over the objective

in the tube of the microscope, and the analyzer rotated so far as necessary to intercept the blue rays of the light, the whole field will be blue. If then a section of a monoclinic crystal, cut parallel to the clinopinacoid, be put upon the stage, the field of view will be changed in color according to the mineral, but by rotation it can be made to appear blue again, and this will take place when an axis of light-movement coincides with the vibration plane of the lower Nicol. If now it be carefully rotated again so as to bring its crystallographic axis parallel with one of the hair-lines in the ocular, the amount of rotation is the angle between the axis of light-movement and the crystallographic axis.

It will be seen that there are three kinds of axes in crystals, which are to be kept distinct.

1. The *crystallographic axes*, around which the crystals are built in planes and lines.

2. The *axes of elasticity*, or ease of light-movement, parallel with which are the planes of vibration of polarized light.

3. The *optic axes*, in the direction of which, if viewed in polarized light, between crossed Nicols, the section acts like an isotropic body.

Some minerals, such as magnetite and pyrite, are wholly opaque, and however thin they may be ground, they are constantly dark. Such must be examined in reflected light, which may be intensified by a bull's-eye condenser, or by parabolic reflectors, of which there are various styles. Some minerals are characteristically colored, even in ordinary transmitted light. The chlorites are generally green, and the pyroxenes are brown or greenish-brown. Some polarize light characteristically, and at once produce such colors or such bands of color as to distinguish them. The triclinic feldspars are remarkable for the striation and banding of the colors of the thin section seen between crossed Nicols. Quartz is characteristically limpid and clear, with beautiful colors in polarized light. In some minerals the directions of the principal cleavages are characteristic. Pyroxene is distinguished from amphibole by the different angle of cleavage seen in a basal section, though in other respects they are very similar. Some minerals are *pleocroic, i. e.*, certain colored rays are absorbed, and, on emerging from the section, a beam of light presents different colored rays. Some are *dichroic*, transmitting two colors, and some *trichroic*. Some simply absorb more light of all kinds in some planes than in others, becoming slightly darker, and then light again on rotation with the analyzer romoved.

Thus, by the employment of the principles of polarized light,

combined with the magnifying quality of the microscope, the internal structure and minutest imperfections and impurities of minerals may be ascertained. A thin section of a crystalline rock presents several minerals at once, cut at various angles with the crystallographic and other axes, and exhibits a field for the use of the nicest discrimination and the most exact mechanical apparatus, but which, when fully wrought out, rewards the laborer with the most abundant and satisfactory fruits.

Those interested in this branch of Geology are referred to the following works:

Rutley—The Study of Rocks; 1879. London.

Hawes—The New Hampshire Geological Survey, Part IV; 1878.

Rosenbusch—Mikroskopische Physiographie der Petrographisch wichtigen Mineralien.

Zirkel—Mik. Beschaff. d. Min. und Gesteine.

" —Report of the 40th Parallel Survey; Vol. VI. Wash'n.

" —Lehrbuch der Petrographie; 1866. Bonn.

Dana, J. D.—System of Mineralogy; 1868. New Haven.

Dana, E. S.—Text-book of Mineralogy; 1877. New Haven.

Decloizeaux—Manuel de Mineralogie; 1862. Paris.

La Saulx—Von Elemente der Petrographie; 1875. Bonn.

Spottiswoode—Polarization of Light. "Nature Series;" 1874.

Boricky—Elemente einen neuen Chem-mikroskop, Mineral und Gesteins Analyse; 1877.

Decloizeaux—Memoire sur l'emploi du Microscope Polarisant.

Queckett—Treatise on the Microscope.

Beale—How to Work with the Microscope; 5th edition, 1880. Philadelphia.

Great diversity prevails in the nomenclature of the crystalline rocks. Not only do different authors, in some cases, employ different names for the same rock in Europe, but the same names are employed with different or with special or exceptional signification. This confusion, already to some extent apparent in American petrological literature, is likely to be perpetuated unless some criterion or some codified principles of nomenclature shall be generally adopted. Prof. J. D. Dana has recently made the attempt* to correct some of the errors that have grown up in the use of terms, and after discarding some of the distinctions that have been made between rocks that really are mineralogically and chemically identical, he presents a series of eight groups, which, not including calcareous and quartzose rocks, will cover, in a

*American Journal of Science and Arts. Third Series. Vol. XVI.

systematic and consistent scheme, the crystalline rocks of the earth. He says:—"Since leucite is a potash-alumina silicate, like orthoclose and microcline (it affording twenty per cent. or more of potash), it is here referred to the same group with the potash feldspars; and nephelite, sodalite and the saussurites being eminently soda-bearing species, they are included with the soda lime feldspars (anorthite to albite). This reference for lithological purposes of these minerals is sustained by their resemblance to the feldspars in constituents, and also in the quantivalent ratios between the alkalies, alumina, and silica, this ratio being in leucite 1:3:8, as in andesite, and in sodalite and nephelite 1:3:4 as in anorthite. The term *potash feldspar*, as used in the headings below is hence to be understood as covering orthoclase, microcline and leucite; and *soda lime feldspar* as including the triclinic feldspars from anorthite to albite, and also nephelite, sodalite, and the saussurites.

"The arrangement is as follows: In the first series the rocks graduate into kinds which are all feldspar, and into others that are all mica; and yet the amount of potash present is approximately the same.

I. The Mica and Potash-Feldspar Series: including Granite, Granulyte, Gneiss, Protogine, Mica Schist, etc., Felsyte, Trachyte, etc., and the Leucite rock of Wyoming.

II. The Mica and Soda-Lime Feldspar Series: including Kersantite, Kinzigite, and the nephelitic kinds—Miascyte, Ditroyte, Phonolyte, etc. (These nephelitic kinds belong almost as well in the preceding series.)

III. The Hornblende and Potash-Feldspar Series: including Syenyte, (with quartz syenyte) Syenyte Gneiss, Hornblende schist, Amphibolyte, Anakyte (this last containing epidote in place of Hornblende); and the nephelitic species Zircon-Syenyte, Foyayte.

IV. The Hornblende and Soda-Lime-Feldspar Series: including Dioryte (with Propylyte) Andesyte, Labradoryte (or Labrador dioryte) etc., and the saussurite rock Euphotide.

V. The Pyroxene and Potash-Feldspar Series: including Amphigenyte.

VI. The Pyroxene and Soda-Lime-Feldspar Series: including Augite-Andesyte, Noryte (Hypersthenyte and Gabbro in

part), Hypersthenyte, (containing true Hypersthene), Doleryte, (comprising Basalt and Diabase), Nephelinyte, etc.

VII. Pyroxene, Garnet, Epidote and Chrysolite rocks containing little or no Feldspar: including Pyroxenyte, Lherzolyte, Garnetyte (Garnet rock), Eclogyte, Epidosyte, Chrysolyte or Dunyte (Chrysolite rock), etc.

VIII. Hydrous Magnesian and Aluminous rocks, containing little or no Feldspar: including Chlorite schist, Talcose schist, Serpentine, Ophiolyte, Pyrophyllite schist, etc."

The Cupriferous Series at Duluth.

The rock at Duluth known as the "Rice Point Granite" affords a good illustration of the use of the polarizing microscope, and of the problems that surround the geologist in working out the stratigraphy and mineral composition of the rocks of the northern part of the State. While this rock is popularly styled *granite,* it cannot be so named by any recognized principles of lithology, except that its texture is generally like that which the word granite implies, viz., *granular.* Its chief ingredients, which are always present, are Plagioclase and Pyroxene, but the latter is sometimes very small in amount, and in some places is almost wanting. The rock has also titaniferous iron, generally magnetic, almost always present, and sometimes in quantity sufficient to render it an iron ore of low grade, while in many parts this iron is wholly wanting. Pyrite, calcite, epidote, and chlorite also exist in some parts in accessory quantities, particularly as geodes, nests, and vein-fillings, or as products of change. The rock is firm, of a gray color, and massive, forming low mountain ranges.

The *Plagioclase* is provisionally taken for Labradorite, a soda-lime feldspar. It is finely striated on the easiest cleavage surface (0), and shows under the microscope a banded structure in thin sections between crossed Nicols, due to the frequent twinning which the triclinic feldspars all exhibit. In some parts of this formation, near Duluth, the plagioclase appears more like Anorthite. It is then in long, narrow, tabular crystals, rather than in crowded grains, or massive, and these crystals cut the pyroxene, from having been first formed in passing from a molten to a solid state.

The pyroxene, cut at random in a thin section of the rock, occasionally shows a foliation parallel to the orthopinacoid,

which is characteristic of the variety of pyroxene styled Diallage. It is of a brownish-yellow color, or nearly colorless when not partially decayed, and non-dichroic; and between crossed Nicols it polarizes in brilliant colors. Much of it is fibrous from incipient change, the products being ferrite and viridite, when it not only plainly shows a fibrous structure in ordinary transmitted light, but also has a more confused or clouded polarization between crossed Nicols. Sometimes minute, perfect crystals are seen. They are short, stout, monoclinic prisms, but more frequently the pyroxene is in grains that show no crystal faces, but simply fill the interstices between the plagioclase crystals, or embrace them.

The iron that is common in this rock seems to be always titaniferous. Very rarely any crystalline forms can be discerned. It seems to have formed in crystalline condition later than the plagioclase and pyroxene. It attaches itself to the poles of the magnet, but yields in decomposition *in situ*, a white subtranslucent or opaque substance characteristic of menaccanite.*

As to the proper designation of this rock, authorities would differ. It is plainly an eruptive rock. The prevailing usage in naming a rock of Silurian age, containing labradorite and lamellar pyroxene, requires the term Gabbro. The term Diabase would be applied by Mr. Rosenbusch when the pyroxene is of the aluminous variety called augite, and that term has been applied by Mr. Pumpelly to the "greenstones" of the Cupriferous Series in Michigan and Wisconsin (*Proceedings of the American Academy of Arts and Sciences*, Vol. XIII), while the term Doleryte, made by Mr. Dana to embrace both Diabase and Basalt, is that which would be demanded by principles published by him in the *American Journal of Science and Arts* for November and December, 1878.

The geological interest connected with this rock is in its intimate associations with a series of metamorphic rocks, which show all stages of metamorphism from perfectly crystalline sienitic granite to a slightly changed or hardly indurated red shale and sandstone. The details of this association can not here be given. It is sufficient to say that at Duluth the red rock may be seen in the quarries suddenly replacing the eruptive rock, and extending sometimes superficially over several square rods in the midst of the igneous rock. In other places it fills interstices and wedge-shaped openings, and at various places in the hills a mile or two

* See the Fifth Annual Report of the Survey, 1876, for an analysis of an impure iron ore from near Duluth.

north of Duluth it may be seen in place forming a large part of the hills. It generally runs under the eruptive rock, but sometimes seems to have been as perfectly fluid as the other, and rises massively to the general surface. The most highly changed and crystalline parts of this red rock are in the higher elevations, where also the coarsest crystals of the eruptive rock are found. Not only do the series of traceable, successive changes from crystallization to sedimentary, fragmental structure, show this red rock to be of different origin from the eruptive rock, but its mineral composition is also equally strong evidence. It consists, when perfectly crystalline, largely of quartz, which is penetrated by numerous acicular crystals of apatite, of red orthoclase feldspar and hornblende. The quartz is in subangular grains, and constitutes from one-fourth to one-half of the whole. The orthoclase is reddened by ferric oxide, and very often its crystalline structure is lost by decay. Both these minerals are pierced by apatite crystals. The hornblende is in brownish-yellow grains, instead of greenish-yellow, and seldom shows, so far as examined, a characteristic dichroicism, though between crossed Nicols it sometimes shows the colors yellow and green in different grains. This rock also generally contains some magnetite in scattering cubes, and sometimes other unimportant accessories.

In its various stages of change this rock, associated with the foregoing eruptive rock, seems to extend along the Lake Superior shore northeastward as far as to Grand Portage, where it leaves the coast of Minnesota and passes under the lake to Isle Royale, a lower formation, making the shore line east of Grand Portage.

Although the actual extension of these red shales and sandstone layers westward from Duluth to Fond du Lac cannot be seen, owing to the prevalence of the drift, it is the most obvious hypothesis to parallelize them with the tilted red shales and sandstones of that locality. There is a similarity of topography extending from one place to the other. The great basin of the lake actually does extend up the St. Louis Valley as far as Fond du Lac, and a little beyond. The strike and dip of the red shales and sandstones is perfectly in accord with the same at Duluth. They are highly tilted at Fond du Lac as if disturbed by the same upheaval. They lie on the Huronian Slates above Fond du Lac, and succeed to them, or to the Animikie Group of Dr. T. S. Hunt, where they leave the shore line near Grand Portage. The identity of these shales and sandstones as one great group can hardly be questioned. This was first recognized by Messrs. Foster and

Whitney in 1849–50*, who regarded them as of the Potsdam age. The separate portions of the formation, with intervening beds of igneous outflow, have unconformable stratification, a necessary result of the disturbance that prevailed in the Lake Superior district during the time of their deposit. What bearing this may have on the reported existence of two sandstone formations along the south shore of Lake Superior, one known as the Keweenian series, involved with the igneous rocks, and the other distinctively as the Potsdam of New York, it is not yet possible to know; but along the northwestern shore of Lake Superior there is certainly no good reason for rejecting the identification of Messrs. Foster and Whitney, supplemented as it was by the unquestioned authority of Prof. James Hall. The incongruous and ponderous "Quebec Group" of the Canadian geologists was extended by Sir. W. E. Logan from the Canadian Territory along the northwestern shore of Lake Superior to Duluth, covering these rocks†, but in the present unsettled condition of the limits and nature of the rocks of that group‡, it is premature to admit of such conjectural extension, even if it be admitted that that group did not, as enlarged, involve much of the earlier Potsdam of New York, and as still further extended by Mr. Selwyn, the upper portion also of the Huronian, making it truly a "remarkable assemblage" to be embraced under a single designation. At the same time it can scarcely be denied that this series, known (with the accompanying igenous rocks) as the "Upper Copper Bearing rocks of Lake Superior," is the equivalent of some part of the eastern Quebec, as urged by Mr. Selwyn, and that there are "no good grounds for assigning either an age or an origin to the cupriferous diorytes, dolerytes and amygdoloids of the eastern townships different from that of the almost identical rocks of Lake Superior."‖ Now the age of the Fond du Lac sandstones is by very general assent of geologists regarded Potsdam. Prof. Irving has lately assigned them to the Potsdam, and colored them continuously with the sandstones that form the southwest shore of Lake Superior in

Report on the Geology of the Lake Superior Land District.

†See the geological map of Canada, published by the Canadian Survey in 1866. Alexander Murray had in 1847 assigned the sandstones at the east end of Lake Superior to the Potsdam age.

A historical summary of the whole question is given in T. Sterry Hunt's Report (E) on the Trap dykes and Azoic rocks of southeastern Pennsylvania.

‡See *The Geological Survey of Canada*, *Report for* 1877-1878, and The Canadian Naturalist, Vol. IX., Nos. 1, 2 and 3.

‖Compare the Fifth Annual Report on the Geological and Natural History Survey of Minnesota, p. 29; also American Journal of Science, 2nd Series, Vol. XXIII, p. 305, where Mr. Whitney has reviewed the subject.

Wisconsin. We hence see the Potsdam in its extension to Duluth involved with these igneous rocks, in upheaval and metamorphism,* and cannot resist the conviction that the whole series known as the Upper Copper Bearing Rocks, or as the Keweenian, or as the Quebec Group, on different authorities, was correctly assigned to the Potsdam at first by Messrs. Foster, Whitney and Hall in 1849, and subsequently by D. D. Owen.

It has been noticed both at Duluth and at other points along the northwest shore of Lake Superior that the Cupriferous rocks show more coarsely and sometimes a porphyritically crystalline structure at points a few miles away from the lake, and especially in the elevated portions, as in the range of hills at Poplar river, known as the Saw-Teeth Mountains. In descending from these hill-ranges the structure gradually becomes finer, and near the coast the rock is more evidently the result of sudden cooling of molten matter, the red shales and conglomerates being simply amygdaloidal, and the igneous rock preserving the wrinkled surfaces and vesicular structure of the successive outflows. At Duluth this succession of changes in the igneous rock is easily traceable, by reason of the removal of the forest and the frequent exposures of the rock throughout the city in the grading of the streets and other excavations. Coincident with this change is the change in the metamorphism of the sedimentary layers. Near the tops of the hills, and at points far inland, the sedimentary rocks are perfectly crystalline, but they almost always show a red color; toward the lake they are finer-grained, and are sometimes hard and "jaspery," with conchoidal fracture. On getting further still from the seat of the metamorphosing forces their real fragmental character is fully revealed. They pass through the stages of hardened siliceous slate and red porphyry to laumontitic calcareous amygdaloid and conglomerate, and even to a true shale, preserving the ripple-marks of gently agitated water. This changed condition of the Potsdam occupies a large area in northeastern Minnesota next south and east of the strike of the Huronian and Animikie belts, and its full extent has not yet been ascertained. What has here been said is intended only as an introduction to the full description of the facts, and the discussion of these interesting geological questions which can be solved so quickly, and are destined to be solved so largely by the use of the polarizing microscope.

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*See R. D. Irving in Transactions of the Wisconsin Academy of Science, Arts, and Letters, 1873-4, p. 117.

III.

THE MUSEUM.

The two rooms in the main University building used for the General Museum, after a long period of confusion, during some of which one or both of them were closed to promiscuous visitation, were put into good order in April, on the completion of the mounting of the *Megatherium Cuvieri*, and were regularly opened to general admission. After the rearrangement of the larger of the Ward series of casts, on suitable supports about the room, the zoological apartment afforded a very inviting and instructive appearance, and the Musuem was much visited both by the people of the city, by students, and by strangers. In the fall of the year the same room received a couple of new cases for the storage of zoological alcoholic specimens. These are placed near the center of the room, but necessarily hide some of the other cases, and crowd the aisles surrounding them; but no better plan could be devised. The room is too small, and if the specimens gathered at the present time were to be all put on exhibition, some other room would have to be provided. Prof. Hall also filled the upright case on the north side of the room with the smaller of the stuffed mammals, and with the soil samples gathered in various parts of the State. These last are in glass jars. Prof. Hall also rearranged some of the corals and sponges in the same room, removing the samples of artificial products, as polished marble slate, etc., to the south room.

In the south room, where the minerals and geological specimens are kept, no additional cases have been built, but the minerals, which before were crowded have been rehandled, mostly by Prof. Hall, and so arranged that they follow successively, from case to case, the system of classification and the numeration of Prof. Dana.

The principal accession to the Museum during the year has been, perhaps, the Estherville aerolite. This important specimen was purchased by the Board of Regents, and was obtained largely through the instrumentality of Prof. E. J. Thompson, who at the

request of the curator, has gathered all the facts attending its fall, and has presented a preliminary report on it. The specimen itself, after being photographed, was, by order of the Executive Committee delivered to Prof. Peckham for analysis. In a subsequent report a full exposition will be given of its chemical, mineralogical and internal structure, accompanied by illustrations. A cast was taken in plaster of Paris. It was then cut for analytical examination. A piece weighing about nine pounds has been sent to Prof. J. Lawrence Smith, who in return has sent the museum twenty from other specimens of meteoric iron and stone, some of them being from Africa, and others from Australia, Greenland, Hungary, Mexico, France, and Poland, as well as from various parts of the United States. The specimens from Greenland are taken from the basalt, and resemble meteoric iron in composition. One specimen from Mexico weighs six and three-fourths pounds, and another contains rare mineral *Daubreelite.* This valuable addition to the Museum makes our collection of meteorites one of the best in the United States: It is contained in a special case in the south room of the Museum.

Prof. Thompson says:

May 10, 1879, was a bright, clear, cloudless day. At 5 o'clock in the afternoon, in full sunshine, this meteorite passed through the air, exploded, and fell in the town of Estherville, Emmet county, Iowa, about ten or twelve miles below the southern boundary of Jackson county, Minnesota, in latitude 43 degrees 30 minutes north, longitude 94 degrees 50 minutes west from Greenwich.

The path it followed marked a course from northwest to southeast, and was seen for a distance of several hundred miles.

Mr. W. L. Wilkins, of Austin, told me, as he was traveling in the northwest part of Mower county, May 10, about 5 o'clock P. M., he heard an unusual crackling and hissing noise about him, and, upon looking up, saw to the west of him the meteor passing. This was more than 100 miles from where it fell.

Mr. Prichard, who resides in the northwest part of Blue Earth county, saw it pass as it seemed far to the northwest of him, and describes it as a most startling and wonderful phenomenon—a huge ball of fire, followed closely by a cloud of fire. Reports from localities still further northwest, some from Dakota, confirm the opinion that its direction was as above stated. Its appearance in the heavens was that of a huge globe of fire, attended by a fiery cloud. The inhabitants residing within the area of a circle whose diameter is six miles, for a few minutes were greatly alarmed; not more at the simple flying ball of fire, which seemed so near to them, than at the terrific explosions immediately above them. Those who did not see it thought an earthquake had occurred, and were in great terror. All agree essentially in giving the facts connected with its explosion and force. The noise accompanying its flight is described as rumbling, cracking, crashing, similar to

that produced by a train of cars crossing a long bridge; then came a very loud report, immediately followed by two distinct reports in quick succession, though not so explosive or loud as the first. It struck the ground in separate masses, together with smaller fragments scattered over an area of three or four miles. There were two large pieces which fell about two miles apart, in a direct northwest line, both at an angle of nearly eighty degrees.

The impressions of those who saw the meteor in the air just at the time of explosion was, that still another large mass fell not far distant. This has been confirmed by the recent finding of a piece weighing 150 pounds, by a trapper named Robert Pietz.

The largest mass, weighing 470 pounds, now at Keokuk, Iowa, penetrated a hard blue clay soil, covered with water, to the depth of twelve feet. The mass weighing 170 pounds, now at the State University, fell on a dry, grassy knoll, and was buried to the depth of five and a half feet below the surface. A few rods from the largest mass was found a fragment weighing thirty pounds, and a school-boy picked up a specimen weighing three pounds a little distance away from the largest. These resembled the great body of the meteorite in all respects.

There was no appreciable difference in time between the explosion and the striking on the earth. The form of all the pieces is like that of rudely detached masses from a quarry, or ejected from the mouth of a volcano. The mass in the museum of the University has an irregular rhomboidal outline, about fifteen by eighteen inches, of an average thickness of six inches, and when first obtained was covered, as most meteorites, with a black shining coat or crust. The largest mass is not so regular in its formation. It is more ragged, and bristles with points of nickelliferous iron. Prof. Heinrich of the Iowa State University pronounced it the most valuable of the two large masses; but a full analyses will probably determine them to be one and the same, while the nickelliferous iron seemed more abundant in the largest, the crystalline formations are far more numerous in the smaller.

Several observers saw the large masses when they struck the ground, and state positively that sod and gravel and dirt scattered far and near, and for a moment the air was filled with flying stones and small masses of earth. The largest struck near a school-house, the smaller within twenty or thirty rods of a dwelling, much to the terror of the inmates. The language of the good old lady sitting by the window at the time, in a measure describes their fright: "My soul! I thought the end of the world had come, and I fell on my face and waited." The concussion produced by its passage through the air was so great that glass was broken in the windows, and in many instances where men were working in the field their horses were completely stunned with fright.

The following is an account given me by one of the nearest eye witnesses: "I was ploughing corn and my team was making to the westward, when suddenly I was startled by a distant whirring sound, which grew louder and nearer, broken and crackling, and as I looked up towards the northwest I saw a large ball of fire sweeping, as it were, down upon me. Instantly there came a loud report, at once followed by a second and third, not so loud as the first. In a few moments several persons were on the spot where they saw it fall, and began digging—for what they knew not—only, as they expressed it, 'that ball of fire they saw fall there.'"

The earth through which it passed presented a cracked, baked appearance, and the openings in the ground made by the meteorites indicated a twisting or revolving motion, as they seemed bored as with a large augur. With reference to its altitude when first seen, and at the moment of the explosion, and the immediate descent, our knowledge, at best must be quite imperfect. Calculating as well as I have been able, from data given me by an expert and skillful civil engineer, who was at the time at work on the Southern Minnesota railroad, and who carefully as possible noted its appearance and attitude, I should judge its height to have been, before the reports were heard, from thirty to forty miles. At the time of explosion it must have been very much less. From a partial and yet unfinished computation, it is thought its velocity to have been between two and four miles per second.

In the lower portion of the mineral cases have been stored temporarily a large number of rock samples and of fossils from abroad, and from the State of Minnesota. Arrangements have been made for completing the shelving intended for these cases, when they will be more convenient and will contain nearly double their present contents.

In the laboratory of the survey a great many boxes have been opened, their contents labeled, the large specimens often dressed down to suitable size, and distributed into classes, registered when their names have been known, and got ready for exhibition in the Museum. The crystalline rocks of the State have yet to receive full examination, and have not been registered. They are simply numbered with blue shellac and alcohol, with the field number of the survey.

The report of Prof. Hall shows what zoological and botanical specimens have been collected by him and Mr. Roberts for the Museum. These are mainly not yet on exhibition, owing to lack of time and proper facilities for their preparation, but they are being arranged as fast as possible.

The accompanying catalogue of registered specimens shows the geological and mineralogical accessions during the year. Exchange of specimens has been made with Prof. C. H. Hitchcock, of the Geological Survey of New Hampshire, Mr. B. H. Wright of Penn Yan, New York, S. H. Baker of the Owatonna Academy, Prof. T. Egleston of the Columbia College School of Mines, and with the Museum of Technology. A part of the Estherville aerolite has also been exchanged with Prof. J. Lawrence Smith for a number of meteoric stones from different parts of the world.

Ever since the beginning of the geological survey a class of specimens has been increasing for which no provision has been made. They consist of ancient stone hammers, arrow-heads, Indian pottery, and other relics of the Mound Builders and the

Indians. It is designed to prepare a suitable place of deposit for these specimens, so that they may be on exhibition, and so that they may serve as a nucleus for the gathering of a full series of these interesting relics. As the State is settled these specimens are discovered, and unless there is a recognized agency for their collection and preservation they are lost sight of, or slip away to other museums. The General Museum of the University, being established by State law, is the proper place of deposit and exhibition of such articles. It is believed that the people of the State who have them in their possession will often be glad to place them in the museum, either temporarily or permanently, when they are once satisfied that they are to be carefully preserved.

CATALOGUE OF SPECIMENS REGISTERED

In the General Museum in 1879.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
190	Oct. 1872	Geol. Survey.......	Trap Rock..	1	Taylor's Falls	Igneous....	N. H. Winchell.
246	Ap. 15, '79	C. W. Hall.........	Variegated Marble....	1	Plymouth, Vt...........	....	Presented by C. W. Hall.
267	1875.	Geol. Survey.......	Has the internal markings of Atrypa, but the shape of Rhynchonella ? (Eatonia ?)....................	24	Spring Valley............	Galena ?...	N. H. Winchell.
762	1876.	"	Limestone..	1	Minneapolis..............	Trent.......	No. 1, of the section below the University. 5th Rep.
2443	June, 1878	Regent Jno. Nicols	Slag, silicified wood, incrustations of Sulphur, Lime, magnesia and decaying rock.............	Indf	Geyser Region, Cal.......	....	Presented by Regent Nicols.
2461	1878.	Geol. Survey.......	Siliceous nodule in shale	1	Near Kasota.............	Cret	N. H. Winchell.
2489	Ap. 15, '79	C. W. Hall.........	Granite..	1	Dummerston, Vt.........	....	Presented by C. W. Hall.
2520	1878.	Geol. Survey.......	Catlinite..	Indf	Pipestone Co.............	Potsdam...	N. H. Winchell.
2577	Ap'l, 1879	"	Fossiliferous metamorphic Conglomerate.........	Indf	Banks of St. Croix R. be- [low Franconia	Potsdam...	Mrs. M. A. Rice (from where the trap and Potsdam Sandstone meet.)
2619	Ap. 15, '79	C. W. Hall.........	Roofing Slate......................................	1	Guilford, Vt............	....	Presented by C. W. Hall.
2683	"	C. W. Hall.........	Micaceous Sandstone.............................	1	Plymouth, Vt...........	....	Presented by C. W. Hall.
2686	1879.	Geol. Survey.	Lingula-bearing green Sandrock...............	1	Kellogg, Minn...........	....	N. H. Winchell.
2687	1877.	"	Quartz and Red Feldspar.........................	2	Redwood Falls...........	Laurentian	C. L. Herrick.
2692	Feb., 1879	"	Chalcocite.................................No. 1.	1	Bristol, Conn	....	By exchange with B. H. Wright.
2693	"	"	Diabantite.................................No. 2.	1	New Britain, Ct.....	....	By exchange with B. H. Wright.
2694	"	"	Forsterite (Boltonite.)......................No. 3.	2	Bolton, Mass............	....	By exchange with B. H. Wright.
2695	"	"	Rhodonite.................................No. 4.	1	Cumberland, R. I........	....	By exchange with B. H. Wright.
2696	"	"	Chloritoid (Masonite.)......................No. 6.	1	Cumberland, R. I........	....	By exchange with B. H. Wright.
2697	"	"	Phyllite....................................No. 5.	1	Cranston, R. I..........	....	By exchange with B. H. Wright.
2698	1872.	"	Siliceous Limestone (fine grained)...............	Indf	Cedar Valley, Mower Co.	....	N. H. Winchell, (traces of fossils.)
2700	1879.	"	Specular Hæmatite	1	Rep. Mine, Marquette... [Mich.	Huronian..	By exchange with S. H. Baker.
2701	Feb., 1879	"	Granular Dolomite	1	Lee, Mass.	....	Julien's Collection II, (No. 1.)

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2702	Feb., 1879	Geol. Survey	Tremolitic Schist	....	New York City		Julien's Collection II, (No. 2.)
2703	"	"	Tremolitic Talc Schist	....	Stapleton, N. Y		" " (No. 3.)
2704	"	"	Dunyte	....	Webster, N. C		" " (No. 4.)
2705	"	"	Ochraceous Serpentine	....	Webster, N. C		" " (No. 5.)
2706	"	"	Tremolitic Serpentine	1	Hoboken, N. J		" " (No. 6.)
2707	"	"	Ophi-Calcite	1	New York City		" " (No. 7.)
2708	"	"	Ophi-Dolomite	1	Montville, N. J		" " (No. 8.)
2709	"	"	Doleryte	1	New Haven, Ct		" " (No. 9.)
2710	"	"	Coarse Diabase	1	Union Hill, N. J		" " (No. 10.)
2711	"	"	Diabase Anamesyte	1	Plainfield, N. J		" " (No. 11.)
2712	"	"	Diabase Anamesyte	1	Paterson, N. J		" " (No. 12.)
2713	"	"	Diabase Aphanyte	1	Union Hill, N. J		" " (No. 13.)
2714	"	"	Labradorite Porphyry	1	Orange, Conn		" " (No. 14.)
2715	"	"	Meta-Diabase	1	Montville, N. J		" " (No. 15.)
2716	"	"	Granitoid Gneiss	1	Clark's I., Maine		" " (No. 16.)
2717	"	"	Granitoid Gneis	1	Mt. Beatty, Ct		" " (No. 17.)
2718	"	"	Granitoid Gneiss	1	Fitz William, N. H		" " (No. 18.)
2719	"	"	Altered Hornblendic Granite	1	Quincy, Mass		" " (No. 19.)
2720	"	"	Chloritic Granitoid Gneiss	1	St. Cloud, Minn		" " (No. 20.)
2721	"	"	Spherulitic Felsyte	1	Mewbury, Mass		" " (No. 21.)
2722	"	"	Dioryte Porphyry	1	Lynn, Mass		" " (No. 22.)
2723	"	"	Hornblendic Gneiss	1	Ticonderoga, N. Y		" " (No. 23.)
2724	"	"	Fibrolitic Gneiss	1	New Rochelle, N. Y		" " (No. 24.)
2725	"	"	Hornblendic Gneiss	1	New York City		" " (No. 25.)
2726	"	"	Clay Slate	1	Lancaster, Mass		" " (No. 26.)
2727	"	"	Fine Grained Arkose	1	Weehauken, N. J		" " (No. 27.)
2728	"	"	Feldspathic Sandstone	1	Portland, Ct		" " (No. 28.)
2729	"	"	Feldspathic Sandstone	1	Dorchester, N. S		" " (No. 29.)
2730	"	"	Hornblendic Arkose	1	Kingston, N. Y		" " (No. 30.)
2731	Ap'l, 1879	"	Magnetite	6	Wash'n Mine, Marquette, Mich.	Huronian	By Exchange with S. H. Baker.
2732	"	"	Magnetite	1	Republic Mine, Mich	"	" "
2733	"	"	Epidote, with silver and copper	1	L. Superior, Mich	"	" "

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2734	Ap'l, 1879.	Geol. Survey.......	Rhodochrosite..	1	L. Superior, Mich........	Huronian..	By Exchange with S. H. Baker.
2735	"	"	Pyrolusite..	1	McComber Mine, Mich ..	"	" "
2737	"	"	Gypsum..	1	Grand Rapids, Mich ?....	Carb.......	" "
2740	1872.	"	Calcareous Tufa..	1	Near Oseola, Wis........	....	N. H. Winchell.
2741	Oct., 1879.	"	Surface Soil	1	Minneapolis	....	C. W. Hall, (moist ground near Monitor Plow works.
2742	1872.	"	So-called Tripoli..	1	⅜ m. above Stillwater, Brown's Cr.............	Drift.......	N. H. Winchell.
2743	Nov., 1878	"	Madison Sandstone..	1	Madison, Wis............	Low. Mag..	C. W. Hall.
2744	"	"	Catlinite..	1	Rice L., Barron Co., Wis.	Potsdam...	By Exchange with Prof. Daniells.
2745	"	C. W. Hall.........	Levanto Marble..	1	Italy.....................	....	Presented by S. Tingley, Providence, R. I.
2746	Aug.2, '79	Col. H. G. Hicks...	Bituminous Coal with silicified wood.............	1	Ogleeby, Ill....	Carb.......	Pres. by E.W. Jordan, Sioux City.
2747	Sep., 1879	S. F. Peckham.....	Lepidolite	1	Windsor, Maine	....	By Exchange with Mrs. Fish.
2748	Oct., 1878.	Geol. Survey.......	Thomsonites in the matrix........................	Indf	Good Harbor Bay, L. Sup	....	C. W. Hall.
2749	"	"	Thomsonites..	"	" "	....	C. W. Hall.
2750	"	"	Sandstone..	"	" "	....	C. W. Hall.
2751	Oct., 1877.	"	Brick Clay..	"	St.P., bet. Sibley & Wacouta sts.	Drift.......	N. H. Winchell, (3 feet above red stratified clay.)
2752	Oct., 1872.	"	Umber Clay..	4	Austin, Minn............	Cret.......	N. H. Winchell.
2753	"	"	Silecious Nodules..	6	" "	"	"
2754	"	"	Cretaceous Clay..	1	" "	"	"
2755	"	"	Colored Cretaceous Clay........................	4	" "	"	"
2756	"	"	Shakopee Limestone....	2	St. Charles...............	Shak	"
2757	Sep., 1879	L. M. Ford.........	Lignite	1	Bismark, Dak. Ter	Cret.......	Presented by L. M. Ford.
2758	July, 1879	Geol. Survey.......	Copper, (Crystals in a Group)	1	Phenix Mine, Mich......	Cup........	N. H. Winchell.
2759	"	"	Fluorite, (in Amethystine cubes) and Galenite (in octahedra)..	1	Thunder Bay, Ont.......	....	"
2760	"	"	Quartz,) Amethyst)..	1	" "	....	" light stain of manganese

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2761	July, 1879.	Geol. Survey	Quartz, (Amethyst)	1	Thunder Bay, Ont.		N. H. W. Amethystine.
2762	"	"	Quartz, (Amethyst)	1	" "		" stained with iron and manganese.
2763	"	"	Quartz, (Amethyst)	1	" "		N. H. W., deeply colored with manganese.
2764	"	"	Quartz, (Amethyst)	1	" "		N. H. W., deeply colored with manganese and iron.
2765	1879.	"	Thomsonites	15	Terrace Pt., L. Superior		N. H. W., Beach-worn.
2766	1876.	Geo. F. Kunz	Rock charged with Franklinite and Zincite	2	Franklin, N. J		
2767	1879.	N. H. Wiuchell	White Gypsum	1	Sandusky, Ohio		N. H. Winchell.
2768	"	N. H. Winchell	Salina Limestone (fetid)	1	Put-in-Bay, L. Erie, O		N. H. Winchell.
2769	1876.	Cent. Exhib.	Pig Iron	1	Alabama		Selma, Rome & Dalton R. R.
2770	Dec. 31, '79	Geol. Survey	Quartzyte (red)	4	Devil's Lake, Wis.	Potsdam?	N. H. Winchell.
2771	"	"	Quartzyte (pink)	2	" "	"	"
2772	"	"	Quartzyte (coarse)	2	" "	"	"
2773	"	"	Talcoseschist	3	" "		"
2774	1875.	"	Slag (very porous)	1	Wyandot, Mich.		Wyandot Rolling Mills.
2775	"	"	Loam Soil		Fountain, Fillmore Co.	Drift	N. H. Winchell.
2776	1877.	"	Red Stratified Clay (Tripoli?)	1	St. Paul	"	N. H. W., between Wacouta and Sibley streets.
2777	1875.	"	Sandy Drift Soil	1	Westcott, Dakota Co	"	N. H. Winchell.
2778	"	"	Surface Soil	1	Hader, Goodhue Co.	"	" 4 miles N. of Hader.
2779	1876.	"	Loam Soil	1	Oronoco	"	"
2780	"	"	Soil thrown up by Gophers	1	Sec. 1, Chatfield	"	"
2781	1875.	"	Soil.	1	Cannon Falls	"	"
2782	1879.	"	Loam (Stratified)	1	Sec. 34, T. 50, R. 13, L. Sup	"	N. H. W. This lies over No. 77.
2783	1876.	"	Blue Hardpan	1	St. Bonifacius	"	"
2784	1877.	"	Lacustrine Clay	1	Winnipeg, Manitoba	"	"
2785	1876.	"	Soil	1	Thomson, Minn.	"	"
2786	1876.	"	Yellow Hardpan	1	St. Bonifacius, Hen. Co.	"	"

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2787	1875.	Geol. Survey.......	Soil of Zumbro Valley....	1	Zumbrota	Drift.......	N. H. Winchell
2788	"	"	Soil of Cannon River Valley	1	Cannon Falls	"	"
2789	"	"	Soil of Spring Valley	1	Spring Valley	"	"
2790	"	"	Loam Soil	1	Chatfield, Sec. 36	"	" Fillmore county.
2791	1876.	"	Gravelly (Hardpan) Clay Subsoil	1	Minnetrista, Hen. Co.	"	"
2792	1878.	"	Duluth Soil	1	Duluth	"	"
2793	1877.	"	Drift Fossils	....	Minneapolis	"	"
2794	1879.	"	Beach Sand	1	Beaver Bay	"	"
2795	"	"	Tripoli (so called)	1	Stillwater	"	Presented by Mrs. A. M. Rice.
2796	"	"	Sioux Quarzyte, (supposed)	1	Emmetsburg, Ia.	Potsdam...	From bottom of a well.
2797	1876.	"	Unios	1	Minnehaha Point	....	Found among boulders and pieces of limerock 60 ft. above river.
2798	1879.	"	Fragment of Boulder	1	Traverse Co., Minn.	Drift.......	Warren Upham, decayed fragments of limerock.
2799	"	"	"Concretions and Pebbles"	4	Detroit	"	Warren Upham.
2800	"	"	Conglomerate	7	New Ulm, (opposite)	Potsdam...	Warren Upham.
2801	Jan. 1879.	C. H. Hitchcock...	Diabase.........No. 1.	1	East Hanover, N. H.	Intrusive...	By Exch. with Geol. Sur. of N. H.
2802	"	" ...	Diabase.........No. 2.	1	Mt. Washington River	" ...	" " "
2803	"	" ...	Diabase, (loose.).........No. 3.	1	Rye, N. H.	" ...	" " "
2804	"	" ...	Diabase.........No. 4.	1	Bartlett, N. H	" ...	" " "
2805	"	" ...	Mica Diabase.........No. 5.	1	Flume, Lincoln, N. H.	" ...	" " "
2806	"	" ...	Mica Diabase.........No. 6.	1	Wakefield, (not Dixville,)	" ...	" " "
2807	"	" ...	Mica Diabase.........No. 7.	1	Waterville. N.H [N.H	" ...	" " "
2808	"	" ...	Labradorite Porphyry.........No. 8.	1	Ossipee, N. H.	" ...	" " "
2809	"	" ...	Anorthite Diabase.........No. 9.	1	East Hanover. N. H.	" ...	" " "
2810	"	" ...	Anorthite Diabase.........No. 10.	1	Concord Vt.	" ...	" " "
2811	"	" ...	Olivine Diabase.........No. 11.	1	Campton Falls, N. H.	" ...	" " "
2812	"	" ...	Dioryte, (porphyritic.).........No. 12.	1	Campton Falls, N. H.	" ...	" " "
2813	"	" ...	Dioryte, (porphyritic.).........No. 13.	1	North Lisbon, N. H.	" ...	" " "
2814	"	" ...	Dioryte, (porphyritic.).........No. 14.	1	North Lisbon, N. H.	" ...	" " "

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2815	Jan., 1879.	C. H. Hitchcock...	Dioryte, (porphyritic.)..........No. 15.	1	Profile House, Franconia,	Intrusive...	By Exch. with Geol. Sur. of N. H
2816	"	"	Dioryte. (porphyritic.)..........No. 16.	1	Dixville Notch. [N. H.	"	" " "
2817	"	"	Dioryte, (Porphyritic calcareous.)..........No. 17.	1	Dixville Notch	"	" " "
2818	"	"	Mica Dioryte, (calcareous.)..........No. 18.	1	Stewartstown, N. H	"	" " "
2819	"	"	Gabbro..........No. 19.	1	Waterville, N. H.........	"	" " "
2820	"	"	Gabbro..........No. 20.	1	Mt. Washington, N. H..	"	" " "
2821	"	"	Gabbro..........No. 21.	1	Gilford, N. H............	Boulders...	" " "
2822	"	"	Gabbro, (decomposed.)..........No. 22.	1	Waterville, N. H.........	Int. Bould's	" " "
2823	"	"	Labradorite, (loose.)..........No. 23.	1	Stark, N. H............	Norian? .:.	" " "
2824	"	"	Felsyte..........No. 24.	1	Mt. Washington, R. N. H	Intrusive...	" " "
2825	"	"	Felsyte..........No. 25.	1	Bemis Brook, N. H	"	" " "
2826	"	"	Black Quartz, (porphyry)..........No. 26.	1	North East Waterville...	Acidic Unstrat'd Metam.	" " "
2827	"	"	" " " ....No. 27.	1	Albany, N. H...........	"	" " "
2828	"	"	" " " ....No. 28.	1	Mt. Lafayette, N. H	"	" " "
2829	"	"	Gray Quartz, (little Quartz.)..........No. 29.	1	Groveton, N. H..........	"	" " "
2830	"	"	Red Quartz, (porphyry.)..........No. 30.	1	Pemiquasset, N. H	"	" " "
2831	"	"	" " " ....No. 31.	1	Albany, N. H...........	"	" " "
2832	"	"	" " " ....No. 32.	1	Waterville, N. H.........	"	" " "
2833	"	"	" " (Granitic.)..........No. 33.	1	Waterville. N. H.........	"	" " "
2834	"	"	Quartz Porphyry. (white.)..........No. 34.	1	Dorchester, N. H........	Metamorp'c	" " "
2835	"	"	Quartz Porphyry..........No. 35.	1	Waterville. N. H	"	" " "
2836	"	"	Porphyry Conglomerate..........No. 36.	1	Waterville, N. H.......	"	" " "
2837	"	"	" " ....No. 37.	1	Albany, N. H...........	"	" " "
2838	"	"	Quartz Porphyry..........No. 38.	1	Twin Mountains, N. H ..	"	" " "
2839	"	"	" " (clay stone porphyry.).....No. 39.	1	Mt. Willard, S. Side, N. H	Albany Granite	" " "
2840	"	"	Breccia of Argillitic Schist..........No. 40	1	Mt. Pequaket, N. H......	Pequaket Breccia.	" " "

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2841	Jan., 1879.	C. H. Hitchcock...	Breccia of Argillitic Schist & Q'tz Porphyry. [No. 41	1	Mt. Pequaket, N. H......	Pequaket Breccia.	By Exch. with Geol. Sur. of N. H
2842	"	"	Quartz Porphyry, (including clay slate.....No. 42.	1	Mt. Willard, N. H	"	" " "
2843	"	"	" " (Granitic.)................No. 43.	1	Mt. Pequaket, N. H......	"	" " "
2844	"	"	" " ....No. 44.	1	Mt. Pequaket, N. H......	"	" " "
2845	"	"	Muscovite Granite, (Gametiferous.).........No. 45.	1	Barrington, N. H........	Rocki'gh'm	" " "
2846	"	"	" biotite granite. ....No. 46.	1	Concord, N. H...	Montalban.	" " "
2847	"	"	" " " ....No. 47.	1	Fitzwilliam, N. H.......	"	" " "
2848	"	"	" " " ....No. 48.	1	Marlboro, N. H..........	"	" " "
2849	"	"	" " " ....No. 49.	1	Troy, N. H..............	"	" " "
2850	"	"	" " " ....No. 50.	1	Manchester, N. H........	L. Winnepesogee Gneiss.	" " "
2851	"	"	" " " (little muscovite, dark.) [No. 51.	1	Plymouth, N. H	Montalban.	" " "
2852	"	"	Muscovite biotite granite. ....No. 52.	1	Hookset, N. H...........	L. Winnepesogee Gneiss.	" " "
2853	"	"	" " " ....No. 53.	1	Lunapee, N. H...........	"	" " "
2854	"	"	" " " ....No. 54.	1	Farmington, N. H.......	Montalban,	" " "
2855	"	"	" " " ....No. 55.	1	Essex Co., Vt...........	"	" " "
2856	"	"	" " " ....No. 56.	1	Effingham, N. H.........		" " "
2857	"	"	" " " ....No. 57.	1	Haverhill, N. H.........	Intrusive ..	" " "
2858	"	"	" " " ....No. 58.	1	Elephant's Head, N. H...	Montalban.	" " "
2859	"	"	" " " (coarser.).......No. 59.	1	Concord, N. H...........	"	" " "
2860	"	"	" " " (coarser.).......No. 60.	1	Fabyan's, N. H..........	"	" " "
2861	"	"	" " " ....No. 61.	1	Dixville, N. H..........	....	" " "
2862	"	"	" " disintegrating granite, [No. 62.	1	Conway, N. H	Conway Granite.	" " "
2863	"	"	Biotite granite............................No. 63.	1	Mt. Willard, N. H	"	" " "
2864	"	"	" " (loose.)....................No. 64.	1	Crawford House, N. H..	"	" " "

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2865	Jan., 1879.	C. H. Hitchcock ...	Biotite granite. (pink.) .... No. 65.	1	Lincoln, N. H.....[N. H.	Conway Granite.	By Exch. with Geol. Sur. of N. H.
2866	"	"	" " (pink.) .... No. 66.	1	Moose Mt. New Durham,	Conway Granite.	" " "
2867	"	"	" " (red.) .... No. 67.	1	Stratford, N. H..........		" " "
2868	"	"	" " .... No. 68.	1	Stark, N. H.......[sarge.	....	" " "
2869	"	"	" " pseudo-porphyritic........ No. 69.	1	White House, Mt. Kear	....	" (not sent by C. H. H.)
2870	"	"	" " .... No. 70.	1	Mission Ridge, Mt. Kear-	....	" " "
2871	"	"	" " contains hornblende. .... No. 71.	1	Newmarket, N. H. [sarge	Exeter Granite.	" " "
2872	"	"	" " .... No. 72.	1	White Mt. Notch, N. H..	Franco'ia Breccia.	" " "
2873	"	"	" " .... No. 73.	1	White Mt. Notch, N. H..	"	" " "
2874	"	"	Gneiss, (included in No. 73.)............... No. 74.	1	White Mt Notch, N. H..	"	" " "
2875	"	"	Gneiss, (included in granite.)............... No. 75.	....	Franconia, N. H.........	"	" " "
2876	"	"	Mica, hornblende granite, (olive green.).... No. 76.	....	Stratford, N. H..........	Chocorua Granite.	" " "
2877	"	"	" " " " No. 77.	....	Bartlett, N. H	"	" " "
2878	"	"	" " " .... No. 78.	....	Frankenstein Cliff, N. H.	"	" " "
2879	"	"	" " " (Albany granite) No. 79.	....	Jackson, N. H.	Albany Granite.	" " "
2880	"	"	" " " .... No. 80.	....	Ossipee, N. H............	Chocorua Granite.	" " "
2881	"	"	" " " .... No. 81.	....	Waterville, N. H...[N. H	Conway Granite.	" " "
2882	"	"	" " " (red.).............. No. 82.	....	Goodrich Falls, Bartlett,	"	" " "
2883	"	"	Granite with muscovite and hornblende..... No. 83.	....	Bemis Sawmill, N. H	....	" " "
2884	"	"	Hornblende Granite, (Albany Granite.)..... No. 84.	....	New Zealand Brook, N. H	....	" " "
2885	"	"	" " .... No. 85.	....	Stark, N. H.............	.. ...	" " "
2886	"	"	" " (red.)................... No. 86.	....	Bartlett, N. H	Conway Granite.	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2887	Jan ,1879.	C. H. Hitchcock ...	Hornblende Granite, (Albany Granite.).....No. 87.	1	Albany, N. H...........	Albany Granite.	By Exch. with Geol. Sur. of N. H.
2888	"	"	" " " ...No. 88.	1	Bemis, N. H	"	" " "
2889	"	"	" " microscopic segmatyte. No. 89.	1	Mt. Carrigain, N. H......	....	" " "
2890	"	"	" " ....No. 90.	1	Stark, N. H.............	Chocorua Granite.	" " "
2891	"	"	" " (red.)..................No. 91.	1	Waterville, N. H.........	....	" " "
2892	"	"	Granitell. ....No. 92.	1	Mt. Ascutney, Vt........	....	" " "
2893	"	"	Feldspar from bed. ....No. 93.	1	Newcastle, N. H.........	....	" " "
2894	"	"	Augite sienyte, (uralitic.) ....No. 94.	1	Jackson, N. H.....	....	" " "
2895	"	"	Hornblende sienyte. ....No. 95.	1	Red Hill, Moultonboro'gh [N. H.	....	" " "
2896	"	"	" " ....No. 96.	1	Columbia, N. H..........	....	" " "
2897	"	"	" " ....No. 97.	1	Stark, N. H.............	....	" " "
2898	"	"	" " (very fine grained.)..No. 98.	1	Albany, N.H..	....	" " "
2899	"	"	Muscovite Gneiss, (garnetiferous.)..........No. 99.	1	Hinsdale (not Chester-[field) N.H	Cambrian Slate.	" " "
2900	"	"	" " ....No. 100.	1	Nashua, N. H............	....	" " "
2901	"	"	Biotite Gneiss...............................No. 101.	1	Holderness, N. H	L. Winnipissiogee Gneiss.	" " "
2902	"	"	" " (quarried.) ....No. 102.	1	Enfield, N. H...........	Bethle'm Gneiss.	" " "
2903	"	"	" " (little feldspar.)..........No. 103.	1	Whitefield, N. H.........	"	" " "
2904	"	"	" " (opalescent quartz.)......No. 104.	1	Bradford, Vt.............	Lisbon.....	" " "
2905	"	"	" " (pseudo porphyritic.).....No. 105.	1	Waterville, N. H.........	Porphy'c Gneiss.	" " "
2906	"	"	" " " " ....No. 106.	1	Franconia, N. H.........	"	" " "
2907	"	"	Biotite Muscovite Gneiss. (pseudo porphyritic.) [No. 107.	1	Newbury, N. H..........	"	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2908	Jan., 1879.	C. H. Hitchcock...	Biotite Muscovite Gneiss, (pseudo porphyritic.) [No. 108.	1	Meredith Village, N. H..	Porphy'c Gneiss,	By Exch. with Geol. Sur. of N. H.
2909	"	"	Biotite Muscovite Gneiss, (pseudo porphyritic.) [No. 109.	1	Bethlehem, N. H	"	" " "
2910	"	"	Biotite Muscovite Gness, (almost micaschist.) [No. 110.	1	Newport, N. H........ ..		" " "
2911	"	"	Biotite Muscovite Gneiss, (little mica.) [No. 111.	1	Bethlehem, N. H.........	Bethle'm Gneiss.	" " "
2912	"	"	" " " ....No. 112.	1	Hanover, N. H...........	"	" " "
2913	"	"	" " " ....No. 113.	1	Whitefield, N. H.........	"	" " "
2914	"	"	" " " [No. 114.]...............	1	East pond, Wakefield, N. H	Montalban.	" " "
2915	"	"	Biotite Muscovite Gneiss (ganetiferous.)...No. 115.	1	Marlow, N. H...........	....	" " "
2916	"	"	" " " (granitic gneiss). No. 116.	1	N. W. from Crawford House, N. H...........	Montalban.	" " "
2917	"	"	" " " ....No. 117.	1	Ossipee, N. H...........	L. Winnipiseogee Gneiss.	" " "
2918	"	"	" " " ....No. 118.	1	Wakefield Corner, N. H.	"	" " "
2919	"	"	" " " ....No. 119.	1	Carroll, N. H............	Bethle'm Gneiss.	" " "
2920	"	"	" " " (almost mica schist.) [No. 120.	1	Wentworth, N. H........	L. Winnipiseogee Gneiss.	" " "
2921	"	"	Biotite Muscovite Gneiss. ....No. 121.	1	Randolph, N. H	"	" " "
2922	"	"	" " " ....No. 122.	1	Salem, N. H............	"	" "
2923	"	"	" Gneiss, (decayed mica pyrrhotite.). No. 123.	1	White Mt. Notch, N. H...	Montalban.	" "
2924	"	"	" Oligoclase gneiss, "W. granite." .No. 124.	1	Swanzey, N. H	Bethle'm Gneiss.	" "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Numbers.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2925	Jan., 1879,	C. H. Hitchcock ...	Biotite Hornblende Gneiss. ....No. 125.	1	Mt. Franklin, Swanzey, [N. H.	L. Winnipiseogee Gneiss.	By Exch. with Geol. Sur. of N. H
2926	"	"	" " " ....No. 126.	1	Littleton, N. H..........	Bethle'm Gneiss.	" " "
2927	"	"	" " " ....No. 127.	1	Wolfeborough, N. H.....	L. Winnipiseogee Gneiss.	" " "
2928	"	"	Protogene gneiss. [No. 128.].....................	1	Littleton, N. H	Lisbon	" " "
2929	"	"	Protogene gneiss, (pseudo porphyritic. ..No. 129.	1	Lancaster, N. H	....	" " "
2930	"	"	" " ....No. 130.	1	Groveton, N. H..........	Lisbon	" " "
2931	"	"	" " (epidotic.) No. 131.	1	Walling's Quarry, Lebanon, N. H............	....	" " "
2932	"	"	" " ....No. 132.	1	Lyman, N. H............	Lisbon	" " "
2933	"	"	" " (red.) ....No. 133.	1	Surry Summit, N. H.....	Bethle'm Gneiss.	" " "
2934	"	"	Mica schist. ....No. 134.	1	Mt. Peqauket, N. H......	Kearsa'ge Andalusite	" " "
2935	"	"	" " ....No. 135.	1	Troy, N. H	Montalban.	" " "
2936	"	"	" " ....No. 136.	1	Ackworth Center, N. H..	Mica Schist & Stauroli'e Rocks.	" " "
2937	"	"	" " (Amoskeag quarry.) ....No. 137.	1	Manchester, (not Bedford [N. H.	L. Winnipiseogee Gneiss.	" " "
2938	"	"	" " ....No. 138.	1	Bemis, N. H............	Montalban.	" " "
2939	"	"	" " (garnetiferous.).............No. 139.	1	Wakefield, N. H..... ...	"	" " "
2940		"	" " ....No. 140.	1	Epping, N. H...........	Merrimack.	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2941	Jan.,1879.	C. H, Hitchcock ...	Mica schist (nearly massive.)............No. 141.	1	White Mt. Notch, N. H..	Kearsa'ge Andalusite.	By Exch. with Geol. Sur. of N. H.
2942	"	"	" " ....No. 142.	1	Orford, N. H............	Mica Schist & Stanroli'e Rocks.	" " "
2943	"	"	" " ....No. 143.	1	Starkweather Stat'n, N. H	Lyman	" " "
2944	"	"	" " ....No. 144.	1	Jackson Falls, N. H......	"	" " "
2945	"	"	" " ....No. 145.	1	Top of Mt. Washington..	Montalban.	" " "
2946	"	"	" " (massive.)..................No. 146.	1	Mt. Wash. carriage road.	Kearsa'ge Andalusite.	" " "
2947	"	"	" " ....No. 147.	1	Littleton, N. H	Mica Schist & Stauroli'e Rocks.	" " "
2948	"	"	" " (whetstone schist.)..........No. 148.	1	Piermont, N. H..........	"	" " "
2949	"	"	" " (ferruginous.)..................No. 149.	1	Ashland, N. H...........	....	" " "
2950	"	"	" " ....No. 150.	1	Colebrook, N. H.........	Lisbon.....	" " "
2951	"	"	" " ....No. 151.	1	Groveton, N. H..........	"	" " "
2952	"	"	" " (fine grained.)................No. 152.	1	North Lisbon, N. H......	Helderberg	" " "
2953	"	"	" " (argillitic.) ....No. 153.	1	Groveton, N. H	Lisbon.....	" " "
2954	"	"	" " ....No. 154.	1	Lydenborough, N. H.....	Rock'gham	" " "
2955	"	"	" " (calcareous.) ....No. 155.	1	Colebrook, N. H.........	Calciferous	" " "
2956	"	"	Andalusite Mica Schist........... ....No. 156.	1	Mt. Willard, N. H........	Kearsa'ge Andalusite.	" " "
2957	"	"	" " " ....No. 157.	1	Mt. Washington, N. H...	"	" " "
2958	"	"	Chiastolite " " ....No. 158.	1	Mt. Wash. carriage road	"	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2959	Jan., 1879.	C. H. Hitchcock...	Fibrolite Mica Schist. ....No. 159.	1	Rumney, N. H...........	Montalban.	By Exch. with Geol. Sur. of N. H.
2960	"	"	" " " ....No. 160.	1	Top of Mt. Washington..	"	" " "
2961	"	"	Staurolite " " ....No. 161.	1	Enfield, N. H............	Mica Schist & Stauroli'e Rocks.	" " "
2962	"	"	" " " ....No. 162.	1	Charleston, N. H	"	" " "
2963	"	"	Garnetiferous Mica Schist. ....No. 163.	1	Top of Mt. Monadnock..	Kearsa'ge Andalu-site.	" " "
2964	"	"	Argillitic " " ....No. 164.	1	Woodsville, N. H........	Lyman	" " "
2965	"	"	" " " ....No. 165.	1	Well's River, Vt.........	"	" " "
2966	"	"	" " " ....No. 166.	1	Stark, N. H.......	"	" " "
2967	"	"	" " " ....No. 167.	1	Lisbon, N. H.............	Swift water for-mation.	" " "
2968	"	"	" " " with copper pyrites. [No. 168.	1	Lyman, N. H	Lyman	" " "
2969	"	"	Argillitic Mica Schist, (black silicious. ....No. 169.	1	Dalton, N. H	Cambrian Slates.	" " "
2970	"	"	" " " ....No. 170.	1	Dalton Copper Mine.....	"	" " "
2971	"	"	" " " ....No. 171.	1	Piper Hill, Stewartstown	"	" " "
2972	"	"	" " " ....No. 172.	1	Stewartstown, N. H	Mica Schist & Stauroli'e Rocks.	" " "
2973	"	"	" " " ....No. 173.	1	Chesterfield, N. H........	Cambrian Slates.	" " "
2974	"	"	" " " ....No. 174.	1	Lyman, N. H	Lyman	" " "
2975	"	"	" " " ....No. 175.	1	Portsmouth, N. H........	Merrimack.	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2976	Jan., 1879.	C. H. Hitchcock...	Argillitic Mica Schist, (with flattened pebbles.) No. 176.	1	Hanover, N. H.	Helderberg.	By Exch. with Geol. Sur. of N. H.
2977	"	"	Argillitic Mica Schist. (with staurolite and garnet crystals.......No. 177.	1	Bernardston, Mass.	Mica Schist & Stauroli'e Rocks.	" " "
2978	"	"	Argillitic Mica Schist, (with staurolite and garnet crystals.......No. 178.	1	Bernardston, Mass.	"	" " "
2979	"	"	Argillitic Mica Schist, (garnetiferous,)....No. 179.	1	Hanover, N. H.	....	" " "
2980	"	"	" " " " ....No. 180.	1	Lynn, N. H.	"	" " "
2981	"	"	" " " ....No. 181.	1	East Lebanon, N. H.	Cambrian Slates.	" " "
2982	"	"	" " " ....No. 182.	1	Lyman, N. H.	"	" " "
2983	"	"	" " " ....No. 183.	1	Dixville Notch, N. H.	Lyman	" " "
2984	"	"	Novaculite. (gray.) ....No. 184.	1	Littleton, N. H	Lisbon.....	" " "
2985	"	"	" (black.).........No. 185.	1	Tamworth, N. H.	....	" " "
2986	"	"	Quartz schist. ....No. 186.	1	Hinsdale, N. H	Coös.......	" " "
2987	"	"	" " ....No. 187.	1	Charleston, N. H	"	" " "
2988	"	"	" " ....No. 188.	1	Chesterfield, N. H.	"	" " "
2989	"	"	" " (micaceous.).........No. 189.	1	Littleton, N. H	Mica Schist & Stauroli'e Rocks.	" " "
2990	"	"	" " ....No. 190.	1	Piermont, N. H.	Coös.......	" " "
2991	"	"	" " ....No. 191.	1	Orford, N. H.	"	" " "
2992	"	"	" " ....No. 192.	1	Bernardston, Mass.	"	" " "
2993	"	"	" " ....No. 193.	1	Winchester, N. H.	"	" " "
2994	"	"	" " ....No. 194.	1	Hinsdale, N. H.	....	" " "
2995	"	"	" " (micaceous.).........No. 195.	1	Lisbon, N. H	....	" " "
2996	"	"	" " ....No. 196.	1	Surry, N. H.	....	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
2997	Jan., 1879.	C. H. Hitchcock...	Quartz schist..........No. 197.	1	Lancaster, N. H.........	Lyman	By Exch. with Geol. Sur. of N. H.
2998	"	"	" " (pyritiferous.)..........No. 198.	1	Dalton, N. H..........	"	" " "
2999	"	"	" " (pyritiferons.)..........No. 199.	1	Lyman, N. H..........	"	" " "
3000	"	"	" " ....No. 200.	1	Hanover, N. H..........	Coös........	" " "
3001	"	"	" " (Whetstone schist.)..........No. 201.	1	Connecticut Lake, N. H.	Lisbon.....	" " "
3002	"	"	" " (chloritic.)..........No. 202.	1	Lyman, N. H..........	....	" " "
3003	"	"	" " ....No. 203.	1	Winchester, N. H........	Coös........	" " "
3004	"	"	Black quartz schist..........No. 204.	1	New Castle, N. H........	Merrimac..	" " "
3005	"	"	Quartz schist, (half fragmental.)..........No. 205.	1	Littleton, N. H.........	Helderberg.	" " "
3006	"	"	Quartzyte ....No. 206.	1	Surry, N. H..........	L. Winnepiseogee, Gneiss.	" " "
3007	"	"	Quartzyte ....No. 207.	1	Raymond, N. H..........	Rock'gham	" " "
3008	"	"	Quartzyte. [No. 208]	1	Amherst, N. H..........	L. Winnepiseogee, Gneiss.	" " "
3009	"	"	Quartzyte, (Buhr-stone.)..........No. 209.	1	Littleton, N. H..........	Helderberg.	" " "
3010	"	"	Quartzyte, (Calcareous.)..........No. 210.	1	Jackson, N. H..........	Montalban.	" " "
3011	"	"	Metamorphic Dioryte..........No. 211.	1	Littleton, N. H..........	Lisbon.....	" " "
3012	"	"	Metamorphic Dioryte..........No. 212.	1	Pittsburg, N. H..........	"	" " "
3013	"	"	Metamorphic Dioryte..........No. 213.	1	Cornish, N. H..........	"	" " "
3014	"	"	Metamorphic quartz-dioryte..........No. 214.	1	Hanover, N. H..........	"	" " "
3015	"	"	Amphibolyte, containing triclinic feldspar. No. 215.	1	N. Lisbon N. H..........	"	" " "
3016	"	"	Amphibolyte ....No. 216.	1	Littleton, N. H..........	"	" " "
3017	"	"	Hornblende schist ....No. 217.	1	Cornish, N. H..........	Huronian ..	" " "
3018	"	"	Hornblende schist..........No. 218.	1	Winchester, N. H........	Bethle'm, Gneiss.	" " "
3019	"	"	Hornblende schist, (black.)..........No. 219.	1	Surry Summit, N. H.....	Huronian ..	" "
3020		"	Hornblende schist, (black.)..........No. 220.	1	Fitzwilliam, N. H.......	Bethle'm, Gneiss.	" "

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3021	Jan., 1879.	C. H. Hitchcock ...	Hornblende schist..........No. 221.	1	Piermont, N. H..........	Huronian ..	By Exch. with Geol. Sur. of N. H.
3022	"	"	Hornblende schist..........No. 222.	1	Stark, N. H..........	"	" " "
3023	"	"	Hornblende schist..........No. 223.	1	Westmoreland, N. H.....	"	" " "
3024	"	"	Hornblende schist, (epidotic and chloritic.)No. 224.	1	Milan, N. H	"	" " "
3025	"	"	Hornblende schist, (garnetiferous.)........No. 225.	1	Hanover, N. H..........	"	" " "
3026	"	"	Hornblende schist..........No. 226.	1	Hanover, N. H..........	"	" " "
3027	"	"	Chloritic quartz schist..........No. 227.	1	Lebanon, N. H..........	Mica schist and Stauro-lite Rocks	" " "
3028	"	"	Chlorite schist..........No. 228.	1	Connecticut Lake, N. H..	....	" " "
3029	"	"	Chlorite schist..........No. 229.	1	Lisbon, N. H..........	....	" " "
3030	"	"	Chloritic Mica schist..........No. 230.	1	Raymond, N. H	....	" " "
3031	"	"	Chlorite schist..........No. 231.	1	N. Lisbon, N. H..........	....	" " "
3032	"	"	Chlorite schist. ....No. 232.	1	Dalton, N. H..........	Cambrian Slates.	" " "
3033	"	"	Clay slate, (Roofing slate.)..........No. 233.	1	Littleton, N. H..........	....	" " "
3034	"	"	Conglomerate..........No. 234.	1	N. Lisbon, N. H..........	Cambrian Slates.	" " "
3035	"	"	Conglomerate..........No. 235.	1	"	"	" " "
3036	"	"	Auriferous Conglomerate..........No. 236.	1	Lyman, N. H..........	Aurif'ro's Conglom.	" " "
3037	"	"	Quartzyte, (vein stone) ....No. 237.	1	Madison Lead Mine, N. H	Montalban.	" " "
3038	"	"	Quartzyte, (vein stone.)..........No. 238.	1	Cornish, N. H..........	Mica schist and Stauro-lite Rocks	" " "
3039	"	"	Quartzyte, (vein stone—auriferous.)........No. 239.	1	Dodge Mine, Lyman, N. H	Cambrian Slate.	" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3040	Jan. 1879.	C. H. Hitchcock ...	Soapstone..........No. 240	1	Francistown, N. H.......	Ferruginous Slate	By Exch. with Geol. Sur. of N. H.
3041	"	"	Soapstone..........No. 241	1	Lancaster, N. H	....	" " "
3042	"	"	Soapstone (talc schist)..........No. 242	1	Oxford, N. H...........	Lyman	" " "
3043	"	"	Soapstone (talc schist)..........No. 243	1	Oxford, N. H...........	Mica schist and Staurolite Rocks	" " "
3044	"	"	Limestone (micaceous)..........No. 244	1	Haverhill, N, H..........	Bethle'm, Gneiss.	" " "
3045	"	"	Limestone (white)..........No. 245	1	N. Lisbon, N. H.........	Helderberg	" " "
3046	"	"	Limstone (gray)..........No. 246	1	Littleton, N. H	"	" " "
3047	"	"	Limestone (crinoidal)..........No. 247	1	Bernardston, Mass.......	"	" " "
3048	"	"	Silicious limestone..........No. 248	1	Cornish, N. H	Calciferous Mica schist.	" " "
3049	"	"	Dolomitic limestone (very silecious)........No. 249	1	Lyman, N. H...........	Lyman.....	" " "
3050	"	"	Magnetite..........No. 250	1	Franconia, N. H.........	L. Winnipiseogee Gneiss.	" " "
3051	"	"	Tourmaline..........	1	Grafton, N. H	....	" " "
3052	"	"	Impure serpentine..........	1	Norwich, Vt..........	....	" " "
3053	"	"	Mica Schist (with dolomite crystals)..........	1	Hanover, N. H..........	....	" " "
3054	"	"	Massive triplite..........	1	Grafton, N. H	....	" " "
3055	"	"	Fibrolite schist (loose)..........	1	Littleton, N H..........	....	" " "
3056	"	"	Near decomposed gabbro..........	1	Waterville, N. H.........	....	" " "
3057	"	"	Porphyry dike in Lake Gneiss..........	1	Centre Harbor N. H......	....	" " "
3058	June, 1879	By purchase	Aerolite	1	Estherville, Iowa.......	....	Prof. E, J. Thompson.
3059	"	Geol. Survey.......	Brick, (maker, Wiest & Kruze)	1	Chaska..........	....	Warren Upham.
3060	"	"	Brick, (maker, Meier)..........	1	Henderson..........	....	"

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3061	June, 1879	Geol. Survey......	Brick, (maker, Gregg & Griswold)................	1	Chaska....................	....	Warren Upham.
3062	"	"	Brick, (maker, Winkelman)..................	1	New Ulm..................	....	"
3063	"	"	Brick, (maker, Kranz)........................	1	Belle Plaine	....	"
3064	"	"	Brick, (makers, Shalaile, Strobach and Streissguth)	1	Chaska....................	....	"
3065	"	"	Brick, (maker, Ahtin)........................	1	Carver	....	"
3066	"	"	Brick, (maker, Ahtin)........................	1	Carver	....	"
3067	"	"	Brick, (maker, Wyman).......	1	Hutchinson................	....	"
3068	"	"	Brick, (maker, Davidson)......................	1	St. Peter..................	....	"
3069	"	"	Brick, (maker, Stoerket)......................	1	New Ulm..................	....	"
3070	"	"	Brick, (maker, Warner)........................	1	Chaska....................	....	"
3071	"	"	Brick, (maker, Matthei)	1	Henderson................	....	"
3072	"	"	Brick.......................................	1	Shingle Creek..............	....	"
3073	"	"	Brick.......................................	1	Milwaukee, Wis...........	....	"
3074	"	"	Brick, (maker, Dauffenbach....................	1	New Ulm..................	....	"
3075	June, 1879	"	Fire-brick, (Maker, Felthausen)............No. 1.	1	Milwaukee, Wis...........	....	"
3076	Sept., 1876	S. F. Peckham....	Fibrous Quartz................................	1	Cranston, R. I............	Carbonif...	
3077	"	"	Bituminous Coal..............................	2	Brewster Mine, Akron, O.	"	Showing mineral charcoal on cleavage surface
3078	"	"	" "	1	" " "	"	Showing iridescence.
3079	"	"	Asphaltum, (Trinidad Pitch)...................	1	Pitch Lake, Trinidad, I.	Tertiary....	....
3080	"	"	Asphaltum, " "	1	"	"	Has been melted.
3081	"	"	Asphaltum....................................	1	Ojai Ranche, Santa Barbara, Cal	Miocene ...	
3082	"	"	Anthracite....................................	1	Cranston, R. I...........	Carbonif...	Metamorphosed nearly into graphite.
3083	"	"	Coal Shale....................................	1	Akron, O..................	"	Showing alternations of fossils and shale.
3084	Oct. 2, '79	"	Cryolite......................................	1	Evigtok, W. Greenland..	....	Exchange with Mus. of Tech.
3085	"	"	Rhodonite, (Parisburgite).....................	1	Parisburg, Sweden.......	....	" "
3086	"	"	Aragonite.....................................	1	Carlstad, Bohemia.......	....	" deposit from hot springs
3087	"	"	Cassiterite...................................	1	Zinnwald, Sax...........	....	By exchange, Mus. of Technology
3088	"	"	Apatite, (Ghosphorite)........................	1	Diez, Nassau.............	....	" " Tech., used for manufacture of manure.

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Serial Number.	OBTAINED. When.	OBTAINED. Whence	NAME.	No. of Specimens.	Locality	Formation.	Collector and Remarks.
3089	Oct. 2, '79	S. F. Peckham....	Crocoite....	1	Beresowsk, Ural	.....	By exch. with Museum of Tech.
3090	"	"	Chrysoprase....	1	Kosemütz, Silesia	.....	" " "
3091	"	"	Cryolite with Galenite, Siderite and Chalcopyrite	1	Evigtok, W. Greenland..	.....	" " "
3092	"	"	Turquois....	1	Fordansmühl. Silesia....	.....	" " "
3093	"	"	Niccolite with Barite....	1	Richelsdorf, Hessia....	.....	" " "
3094	"	"	Alunite....	1	Nagymazy, Hungary....	.....	" " "
3095	"	"	Tarnovicite, Crystals with Galenite....	1	Tarnowitz, Upper Silesia	.....	" " "
3096	"	"	Scheelite with Quartz....	1	Zinnwald, Sax....	.....	" " "
3097	"	"	Siderite in Cryolite....	1	Evigtok, W. Greenland..	.....	" " "
3098	"	"	"Soft Carbonate Ore"....	2	Leadville, Col....	.....	By ex. with Mus. Tech., Iron Mine
3099	"	"	Nacrite....	1	Lime Rock, R. I....	.....	By ex. with Mus. of Technology.
3100	"	"	Manganite....	1	Negaunee, Mich	.....	Geo. J. Brush, Mus. of Technology
3101	"	"	Native Copper in Calcite Crystals....	1	Quincy Mine, Mich....	.....	By ex. with Mus. of Technology.
3102	"	"	Pyropissite....	1	Weissenfels. Sax. (near Kelle)....	.....	" " "
3103	"	"	Tellurium Pyrite (?)....	1	Sunshine, Col. Am. mine.	.....	" " "
3104	"	"	Siegburgite, (succinite, a fossil resin)....	1	Siegburg, Silesia....	.....	" " "
3105	"	"	Mendipite....	1	Burthen, Up. Silesia....	.....	" " "
3106	"	"	Fulgerite....	1	Starcynon, near Olkurz, Polonia....	.....	" " "
3107	"	"	Amethyst....	1	19 ms. N. of Gd. Portage.	.....	" " "
3108	Oct. 3, '79	R. O. Sweeny....	Pyrite....	1	Galena, Ill....	.....	.....
3109	"	J. F. Tostevin	Tennessee Marble....	2	Knoxville, Tenn....	.....	.....
3110	"	"	" " (Crinoidal)	2	Rogersville, Tenn....	.....	.....
3111	"	"	Formoso Marble....	1	Germany....	.....	.....
3112	May 22, '75	W. R. Marshall....	Lignite....	1	Missouri r. (near mouth of Knife R)....	.....	From 7 feet bed on E. side of R.
3113	Oct. 4, '79	Geol. Survey....	Sandstone, (in which are found the reptilian tracks [of the Conn. Valley	2	Middlefield, Conn..	Triassic....	C. W. Hall.
3114	"	"	Conglomerate....	2	Meriden, Conn....	"	"
3115	"	"	Sandstone, (coarse)....	2	" "	"	"

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3116	Oct. 4, '79	Geol. Survey	Doleryte	2	Near Middlefield, Conn.	Triassic(?)	C. W. Hall.
3117	"	"	Sandstone	2	Long Meadow, Mass.		"
3118	"	"	Conglomerate	2	Newton Highlands, Mass.		"
3119	"	"	Gneiss, (Granitoid)	2	Gardner, Mass.		"
3120	"	"	Gneiss		Royalston, Mass.		"
3121	"	"	Gneiss		Orange, Mass.		"
3122	"	"	"Cape Ann Granite"		Cape Ann, Mass.		"
3123	"	"	Granite, (finely Crystalline)	2	Fitzwilliam, N. H.		"
3124	"	"	Granite	3	Fitchburg, Mass.		"
3125	"	"	Quartz Crystals	3	Greenwood, Maine		" Presn'd by G.F. Leonard
3126	"	S. F. Peckham	Blende and Quartz	8	Eame's Mine, Pie I. L. Sup		By ex. with Mus. of Technology.
3127	"	"	Blende, Galena and Quartz	1	" "		" " "
3128	"	"	Magnetite	1	Port Henry, N. Y.		" " "
3129	"	S. F. Peckham	Cannel Coal	1	Kanawha Co., W. Va.	Carb.	" " "
3130	"	"	Argentiferous Galena, (400 oz. of Sil. per ton)	1	Veto Lode, near Georgetown, Col.		" " "
3131	"	"	Calcite	4	Pie Island, Lake Superior.		" " "
3132	"	"	Black Band Ore, (Calcined)	1	Davis Creek, Kanawha Co., W. Va.	Carb	" " "
3133	"	"	Black Band Ore	1	Davis Creek, Kanawha Co., W. Va.	"	" " "
3134	"	"	Barite	1	Baker's Mine, Pigeon Pt. Lake Sup.		" " "
3135	"	"	Barite and Calcite	3	Baker's Mine, Pigeon Pt., Lake Sup.		" " "
3136	"	"	Barite and Blende	1	Baker's Mine, Pigeon Pt., Lake Sup.		" " "
3137	"	"	Drusy Quartz	1	Pigeon Pt. Lake Superior.		" " "
3138	"	"	Graphite, (Pebbly)	10	" "		" " "
3139	"	"	" (in matrix)	1	" "		" " "

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3140	1878.	C. L. Herrick	Buhrstone, (from the great mill explosion)	4	Minneapolis		
3141	1879.	Geol. Survey	Terra-Cotta Brick	1	Red Wing, Minn		N. H. W.
3142	1875.	"	Artificial Stone	4	Minneapolis		N. H. W.
3143	1873.	"	Unburnt Brick	1	Upper Agency, Minn. R.		N. H. W., from the pile abandoned by the Indians on the outbreak, Aug. 19, 1862.
3144	1878.	B. Juni	Buhrstone, (from the great mill explomon)	1	Minneapolis		
3145	1879.	G. F. Kunz	Lithio-Ferrite	1	Regensdorf, Westphalia		
3146	"	Geol. Survey	Granite, (near the conglomerate)	3	Opposite New Ulm		Warren Upham.
3147	"	"	Red Quartzyte	2	Faxon, (Doheny's Quar'y)		"
3148	"	"	Siliceous Limestone	2	Jessenland, (Young's Qy.)		"
3149	"	"	Red Quartzyte, (E. part of R. R. cut)	3	Near New Ulm, 30 rds. E. of the bridge	Potsdam	"
3150	"	"	"	2	Baasen's Qy, n. New Ulm	"	"
3151	"	Geo. F. Kunz	Chromite, ("Bird's Eye")	1	Maryland		
3152	"	"	Tetrahedrite, ("Annivite")	1	Anniverthal, Switzerland		
3153	"	"	Leucite	1	Vesuvius, Italy		
3154	"	"	Hydrotalcite	1	St. Lawrence, N.Y.		
3155	"	"	Pyroxene, (Malacolite)	1	Mähren		
3156	"	"	Gadolinite	1	Ytterby, Sweden		
3157	"	"	Arsenic, (native)	1	Freiburg, Saxony		
3158	"	"	Arragonite, ("Mozsottite")	1	Chili, S. A.		
3159	"	"	Euphyllite	1	Chester, Mass.		
3160	"	"	Arragonite	1	Bilin, Bohemia		
3161	"	"	Bismuth	1	England		
3162	"	"	Wolchonskoit	1	Montague d'Ellineatskaia Ural		
3163	"	"	Berthierite	1	Braunsdorf, Saxony		
3164	"	"	Shielite	1	Monroe, Conn.		
3165	"	"	Chalcocite, (Redruthite)	1	England		

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Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3166	1879.	Geo. F. Kunz	Chabazite, (Phacolite)	1	Salest, Bohemia		
3167	"	"	Menaccanite, (Washingtonite)	1	New York City		
3168	"	"	Garnet, (Allochroite)	1	Blandan, Mähren		
3169	"	"	Lathanite and Cerite	1	Bastnas, Sweden		
3170	"	"	Garnet, Black Circular aggregations	1	East Rock, N. Haven, Ct.		
3171	"	"	Cobaltite	4	Tunaberg, Sweden		
3172	"	"	Cassiterite	1	Duluth, Minn., Com. Engl. 1,960 ft.		
3173	"	"	Allanite	1	Virginia (?)		
3174	"	"	Argentite	1	Freiberg, Saxony		
3175	"	"	Octahedrite, (Anatase)	1	Tavetsch, Switzerland		
3176	"	"	Pitchstone, (Peclistein)	1	Garsbach, Mähren		
3177	"	"	Senarmontite	1	Ain Babouches		
3178	"	"	Alunogen, (Keramohalite)	1	Schemnitz, Hungary		
3179	"	"	Tourmaline, (Indicolite and Rubellite) & Lepidolite	1	Roznend, Mähren		
3180	"	"	Zoisite	1	Bedazzo, Tyrol		
3181	"	"	Orpiment	1	Lucky-boy Mine, Utah		
3182	"	"	Silver, (Native)	1	Mexico		
3183	"	"	Opal, (Hyalite var.)	1	Waltsch, Mähren		
3184	"	"	Rhodocrosite	1	Kapnik, Hungary		
3185	"	"	Iolite	1	Haddam, Conn.		
3186	"	"	Serpentine, (pseudo after Feldspar)	1	Fassenthal, Tyrol		
3187	"	"	Meionite	1	Mount Vesuvius		
3188	"	"	Barite	1	Hungary		
3189	"	"	Hydromagnesite, (Lancasterite)	1	Texas, Lancaster Co., Pa.		
3190	"	"	Dufrenite	1	Binnenthal, Switzerland		
3191	"	"	Orpiment	1	Felsobanga, Hungary		
3192	"	"	Quartz	1	Brazil, S. A.		
3193	"	"	Wollastonite	1	Pzilowa, Banat		
3194	"	"	Tetrahedrite, ("Falertz")	1	Kapnik, Hungary		Fine Crystals.

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3195	1879.	Geo. F. Kunz	Copper Ore, (Argentiferous)	1	Arizona		
3196	"	"	Mendozite, ("Alum"	1	Centennial Exposition		Made from Cryolite
3197	"	"	Quartz, (Bloodstone)	1	India		
3198	"	"	Apatite, ("Spargelstein")	1	Zoptan, Mähren		
3199	"	"	Apatite	1	Bob Lake, Canada		
3200	"	"	Penninite and Garnet	1	Zermath, Tyrol		
3201	"	"	Alabanite, ("Mangan-blende")	1	Magyag [N.Y.		
3202	"	"	Arragonite	1	Ball's Cave, Scoharie Co.,		
3203	"	"	Cerussite	1	Southampton, Mass		
3204	"	"	Apatite, ("Phosphorite")	1	Limburg, Nassau		
3205	"	"	Realgar	1	Kapnik, Hungary		
3206	"	"	Anorthite—After Feldspar	1	Tyrol		
3207	"	"	Molybdenite	1	Zinnwald, Bohemia		
3208	"	"	Stilpnomelane	1	Baern, Bohemia		
3209	"	"	Antillite, (impure Serpentine)	1	Cuba		
3210	"	"	Hatchittite	1	Bologne, Italy		
3211	"	"	Chalcocite	1	Bristol, Conn		
3212	"	"	Sepiolite, (Meerschaum)	1	Mähren		
3213	"	"	" "	2	Schnbenka, Turkey		
3214	"	"	Albite, (Pericline)	1	Models, Switzerland		
3215	"	"	Ulexite, (Pricexite)	1	Curry Co., Oregon		
3216	"	"	Pinite, (Liebenerite)	1	Piccinega, Tyrol		
3217	"	"	Astrophyllite	1	El Paso Co., Col		
3218	"	"	Chalcocite	1	Bristol, Ct		
3219	"	"	Danalite with Annite	1	Rockport, Mass.		
3220	"	"	Petzite and Altaite	1	Colorado		
3221	"	"	Orthite and Yttrotantalite	1	Ytterby, Sweden		
3222	"	"	Obsidian	1	Mexico		
3223	"	"	Breithauptite	1	Andreasburg, Harz Mts		
3224	"	"	Turnerite	1	St. Brigetta, Switz		

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3225	1879.	Geo. F. Kunz	Iodyrite	2	Caracoles, Chili		
3226	"	"	Mica, (Blumoce)	1	New York City		
3227	"	"	Bromyrite	1	Caracoles, Chili		
3228	"	"	Pyroxene, (Fassaite)	1	Fassenthal, Switz		
3229	"	"	Ardennite	1	Salm Chateau, Bel.		
3230	"	"	Lazulite	1	Krieglach, Steirmath		
3231	"	"	Yttrotantalite	1	Ytterby, Sweden		
3232	"	"	Genthite, (Noumeite)	1	Victoria, Aust		
3233	"	"	Cerargyrite, (In Plates)	1	Caracoles, Chili		
3234	"	"	Crocoite	1	Beresof, Siberia		
3235	"	"	Uraninite. (Pitch-blende)	1	Prizbrau, Bohemia		
3236	"	"	Binnite	1	Binnenthal, Switz		
3237	"	"	Allanite, (Orthite)	1	Arendal, Norway		
3238	"	"	Scorodite	1	Westphalia		
3239	"	"	Torgite	1	Sehrbach, Herz		
3240	"	"	Scheelite	1	Zinnwald, Bohemia		
3241	"	"	Pyrochlore	1	Miask, Ural		
3242	"	"	Alunite	1	Mieues (?), Hungary		
3243	"	"	Cassiterite	1	Zinnwald, Bohemia		
3244	"	"	Orthoclase, (Chesterlite)	1	Chester Co., Penn		
3245	"	"	Heulandite	1	Nova Scotia		
3246	"	"	Zoisite	1	Alvater, Mähren		
3247	"	"	Heulandite	1	Nova Scotia		
3248	"	"	Pyroxene, (Pilkarandite)	1	Pilkarauda, Finland		
3249	"	"	Pihlite, ("Cymatolite")	1	Goshen, Mass		
3250	"	"	Vesuvianite, (Idocrase)	1	Fassenthal, Tyrol		
3251	"	"	Cerargyrite	1	Caracoles, Chili		Fine crystals
3252	"	"	Yttrotantalite	1	Arendal, Norway		
3253	"	"	Malachite	1	Russia		
3254	"	"	Pyroxene (Coccolite)	1	Amity, N. Y.		

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3255	1879.	Geo. F. Kunz	Bournonite and Chalcopyrite	1	Felsobanga, Hungary		
3256	"	"	Amphibole, (Actinolite)	1	Arendal, Norway		
3257	"	"	Malachite, (Crystals)	1	Westphalia		
3258	"	"	Copper Ore—Argentiferous	1	Arizona		
3259	"	"	Orthoclase, (Adularia)	1	St. Gothard		Fine large crystals.
3260	"	"	Jordanite	1	Binnenthal, Switz		
3261	"	"	Hematite, (Martite)	1	Digby, Mich		
3262	"	"	Chloritoid	1	Smithfield, Rd. Id		
3263	"	"	Cryophyllite and Orthoclase, (Amazon-stone)	1	Rockport, Mass		
3264	"	"	Oligoclase and Kjerulfine	1	Brevig, Norway		
3265	"	"	Smaltite, (Speiskobalt)	1	Dobshau, Mähren		
3266	"	"	Cerargyrite	1	Caracoles, Chili		
3267	"	"	Garnet, (Essonite)	1	Tyrol		
3268	"	"	Orthoclase, (Lexoclase)	1	Bloomingdale, N. J		
3269	"	"	Quartz	1	Nova Scotia		Having a fused appearance.
3270	"	"	Pyrargyrite	1	Kapnik, Hungary		
3271	"	"	Wolframite	1	Zinnwald, Bohemia		
3272	"	"	Lazulite	1	Matterhorn, Switz		
3273	"	"	Apophyllite, (?)	1	Aussig, Bohemia		Labeled Albin by Kunz.
3274	"	"	Aemite	1	Arendal, Norway		Crystals occurring in Beryl
3275	"	"	Wallongongite	1	Wallongong, Aus		
3276	Dec., 1878	G. F. Townsend	Granite, (red)	1	Red Beach, Me		Presented by George F. Townsend
3277	Sept., 1879	Regent Chute	Calcite and Pyrites, Geode of Pyrite on Calcite in impure limestone	1	Taylor's Falls		
3278	"	Geol. Survey	Doleryte, ("Rice Pt. Granite")	1	R. R. Depot, Duluth		C. W. Hall.
3279	"	"	Feldspar	1	Summit of Carlton's Peak		" "
3280	"	"	"	Indf	Beaver Bay, L. Sup		" "
3281	Dec., 1879	J. S. Clark	Gold, (free gold in Quartz)	3	Goldenville, Guysboro Co., N. S		Presented by J. S. Clark.

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3282	1879.	Geol. Survey	Peat	1	Minnesota		N. H. Winchell,
3283	1876.	Cen. Exhibition	Coal Dust Utilized	2			Presented by Anthracite Fuel Co., Rondout, N. Y.
3284	1879.	Geol. Survey	Red Quartzyte	2	Near New Ulm	Potsdam	W. Upham, Meierding's Quarry.
3285	"	"	" "	3	Near New Ulm	"	" " From N. W. part of outcrop.
3286	"	"	Gneiss	2	Little R'k, n'r Ft. Ridgely		W. Upham.
3287	"	"	Granite	2	Little R'k, n'r Ft. Ridgely		" "
3288	"	"	"	3	Little R'k, n'r Ft. Ridgely		" " 10 feet from Gneiss
3289	"	"	Green Sandrock	1	Habron, Nicollet Co		" " From the tail-race below mill.
3290	"	"	St. Lawrence Limestone	1	Hebron, Nicollet Co		" " South quarry of Mrs. Dunham.
3291	"	"	" "	2	Hebron, Nicollet Co		" " S. E. quarry of Mrs. Dunham.
3292	"	"	" "	2	Hebron, Nicollet Co		" " Phillips quarry.
3293	"	"	" "	4	St. Lawrence		" " Bisson's quarry.
3294	"	"	Shakopee "	5	Louisville, Scott Co		" " Mrs. Spencer's quarry.
3295	"	"	" "	1	Louisville, Scott Co		Mrs. Spencer's. lower layers.
3296	"	"	" "	7	Opposite Mankato		W. Upham, Marsh's quarry.
3297	"	"	" "	1	Opposite Mankato		" " 1 foot above Jordan sandstone.
3298	"	"	" "	2	Park Prairie		" " "Linter."
3299	"	"	" "	1	Park Prairie		" " "Osbornes."
3300	"	"	" "	3	Park Prairie		" " "Linter."
3301	"	"	Jordan Sandstone	2	St. Peter	Jordan	" " Concretions 10 ft. below top.
3302	"	"	Red Shale	3	St. Peter	Shak	" " at Base of Shak.
3303	"	"	Limonitic Sandrock, (Magnesian)	1	St. Peter	Jordan	" " under No. 3302.
3304	"	"	Shakopee Limestone	5	St. Peter	Shak	" " Asylum quarry.

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Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3305	1879.	Geol. Survey	Shakopee Limestone	5	Louisville	Shak	W. Upham, Contre's quarry.
3306	"	"	Red Shale	Indf	Courtland	Cret.	" " Heyman's Limekiln.
3307	"	"	Niobrara Limestone	2	Courtland	"	" " " "
3308	"	"	White Shale	2	Courtland	"	" " " "
3309	"	"	Greenish Clay	1	Courtland	"	" " " "
3310	"	"	Dakota Sandstone	1	Courtland	"	" " Greenholz quarry.
3311	"	"	" Conglomerate	1	Courtland	"	" " " "
3312	"	"	" Sandstone	2	Courtland	"	" " Fritz's quarry.
3313	"	"	" " Concretionary	1	Courtland	"	" " " "
3314	1877.	"	Drillings from Bottom of Deep Well	....	Herman	....	N. H. W.
3315	1878.	"	Shark's Teeth—Hemipristis serrata, Ag	22	Charleston, S. C	Eocene	A. W. Vogdes.
3316	"	"	" " Galiocerdo contortus, Ag	29	Charleston, S. C	"	"
3317	"	"	" " Oxyrhiria plicatilis, Ag	1	Charleston, S. C	"	"
3318	1880.	Dr. Riheldaffer	Iron Pyrites	1	Pennsylvania	Coal Meas.	Presented by Dr. J. H. Riheldaffer.
3319	1879.	Geo. F. Kunz	Zinc Hausmannite, (Helaerolite)	1	Ogdensburg, N. J	....	....
3320	"	"	Haferite	1	Iserlohn, Westphalia	....	....
3321	"	"	Ludergite	1	Banat, Hungary	....	....
3322	Jan. 30, '80	Prof. T. Egleston	Cuprite, (Chalcotrichite)	1	Copper Falls Mine, Mich.	Conglom	By Exchange.
3323	"	"	Columbite	4	Chesterfield, Mass	....	"
3324	"	"	Zircon, (Œrstedite) and Aglaite	5	Chesterfield, Mass	....	" containing 4 per ct, of Uranium.
3325	"	"	Delessite	3	Copper Falls Mine. Mich.	....	"
3326	"	"	Enstatite	1	St. Etienne, Styria	....	"
3327	"	"	Martite	5	N. York mine, L. Sup	Huronian	" Pseudomorph after magnetite.
3328	"	"	Allanite	1	Port Henry, N. Y	....	"
3329	"	"	Allanite	3	Edenville	....	"
3330	Feb., 1880	Geol. Survey	Conularia Trentonensis	1	Minneapolis	Trenton	Presented by C. E. Chatfield, Esq.
3331	Aug., 1878	"	Thomsonite	Indf	Eclipse Beach, L. Sup	Cuprif.	....
3332	"	"	" (Lintonite)	"	Eclipse Beach, L. Sup	"	....

Catalogue of Specimens Registered in the General Museum in 1879—Continued.

Serial Number.	OBTAINED. When.	OBTAINED. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3333	Aug., 1878	Geol. Survey	Thomsonite	Indf	Terrace Pt.	Cuprif	N. H. Winchell (of T. Mayhew.)
3334	"	"	" (Lintonite)	"	Terrace Pt.	"	" "
3335	July, 1879	"	"	"	Terrace Pt.	"	N. H. Winchell.
3336	"	"	" (Lintonite)	"	Terrace Pt.	"	"
3337	Aug., 1879	"	" (?)	"	N. shore of Isle Royale	"	"
3338	"	"	Chalcocite	....	St. Croix Falls, Wis.	"	"
3339	Dec., 1879	J. Lawrence Smith	Meteoric Stone—Fell June 15, 1821	1	Jurenas, France		By Exchange with J. Law. Smith.
3340	"	"	" " Fell May 14, 1834	1	Orgueil, France		" "
3341	"	"	" " Fell October 13, 1838	1	Cold Bokkevald, Cape of Good Hope, Africa		" "
3342	"	"	" "	1	Waconda, Kansas		" "
3343	"	"	" "	1	Cynthiana, Ky.		" "
3344	"	"	Meteoric Iron	1	Caanbourm, Australia		" "
3345	"	"	Native Iron—In composition somewhat like Meteoric Iron	2	From the basalt, Ovifach, Greenland		" "
3345	"	"	Meteoric Iron	1	Sevier Co., Tenn.		" "
3346	"	"	" Stone	1	Warren Co., Mo.		" "
3347	"	"	" Iron	1	Carthage, Smith Co., Ten		" "
3348	"	"	Daubreelite—From Meteoric Iron	1	Coahuila, Mex.		" "
3349	"	"	Meteoric Stone—Fell June 9, 1866	1	Kuyahinya, Hungary		" "
3350	"	"	" Iron	1	Babb's Mill, Green Co., Ten		" "
3351	"	"	" Stone—Fell June 30, 1868	1	Pultusk, Poland		" "
3352	"	"	" " Fell May 9, 1827	1	Drake Creek, Tenn.		" "
3353	"	"	" Iron	1	Casey Co., Kentucky		" "
3354	"	"	" "	1	Murfreesboro, Tenn.		" "
3355	"	"	" "	1	Robertson Co., Tenn.		" "
3356	"	"	" "	1	Bates Co., Mo.		" "
3357	"	"	" " with Daubreelite in Troilite	1	Coahuila, Mex		" "
3358	"	"	" Stone—Fell February 12, 1875	1	Iowa City, Iowa		" "
3359	"	"	" Iron	1	Near Milwaukee, Wis.		" "
3360	"	"	" " (weighs 6½ pounds)	1	Coahuila, Mex.		" "

IV.

PALÆONTOLOGY.

Descriptions of New Species of Brachiopoda from the Trenton and Hudson River Formations in Minnesota.

BY N. H. WINCHELL.

GENUS **Lingula,** (Bruguiere.)

(Encyc. Meth. I. tab., 250.

Gen. Char.—Sub-equivalve, equilateral, longitudinally ovate or sub-pentagonal, both valves channelled equally at the beaks for the passage of the pedicle (one beak a little longer and more pointed than the other, which latter has a narrow internal flat area;) internally each valve has a thickened pad in the middle, and the shorter one has in front of it a prominent internal septum. The species of the genus grow wider proportionally with age. (McCoy, *Brit. Pal. Foss.*)

This genus has been regarded as one of the few living forms that began their existence among the earliest marine inhabitants of the globe, (*Pal. N. Y.*, Vol. I, p. 94) but, according to Prof. James Hall, it is "extremely doubtful whether we have yet evidence to claim the occurrence of a single species of true *Lingula* in the lower palæozoic rocks," (23*rd Reg. Rep.*, p. 245.) The older Linguloid forms in the Potsdam sandstone have been distributed, at least provisionally, among the new genera *Lingulella* (Salter,) *Lingulepis* (Hall,) *Obolella* (Billings,) and *Lingulops* (Hall.) These bracheopods have fragile phosphatic valves, a circumstance which has served to preserve their lustre in many cases where the exterior of the shell is exposed freshly, and to prevent their

absorption into the rock. They are easily distinguishable from the other genera of brachiopods found in the Trenton Group of rocks. Until more definite information is obtained of the differences and distinctions among the above-mentioned new genera, it will be admissible to place them all under the old term so far as they occur in the Trenton Group.

Lingula Minnesotensis. (*N. sp.*)

Reference and Synonymy.—Lingula quadrata, *Winchell*, Geol. and Nat. Hist. Survey, Annual Report for 1875, p. 49; also *ibid* for 1876, p. 54, 215; also *ibid* for 1877, p. 164.

Shell sub-quadrate or oblong, the sides nearly straight and parallel, but with a little convexity; the anterior angles rounded, the sides passing into the posterior lateral edges with a uniform curvature; the beak of one valve projecting beyond the other; the shorter valve more elevated and tumid than the larger, both transversely and longitudinally; on the exfoliation of the shell each side of the cast shows a central furrow extending from the beak about three-fourths the length of the shell; in front of the postero-lateral margins is a somewhat depressed space on either side of the beak, and on either valve, the convexity of the valves rising more rapidly at a short distance from the margins; this depression along the posterior angles gradually disappears as the central elevated area widens toward the front.

Although the true surface of the shell is generally exfoliated, on the interior casts are concentric, broad plications of growth. These are crossed, at least along their central front, by longitudinal radiations. Along the depressed postero-lateral margins these concentric plications are crowded and imbricated. Between, and also covering these plications of growth, are fine concentric striæ over the whole surface.

Length nearly ⅕ inch; width a little over ⅛ inch.

The species resembles *L. Lewisii* (Sow.) but has not the straight postero-lateral margins (*Brit. Pal. Foss.* p. 253.) It also resembles *L. quadrata*, (Eich.) but is but little more than one-half the size of that, and the difference in the convexity of its valves is greater.

In the report for 1875 this species was identified as *L. quadrata* (Eich.) at Taylor's quarry near Fountain.

Locality and Formation. Olmsted county, (W. D. Hurlbut.) Fountain, Fillmore county, and Wanamingo in Goodhue county.

Minneapolis, associated with *Strophomena deltoidea* (Con.) In the Trenton limestone.

Collectors. N. H. Winchell; at Minneapolis H. V. Winchell.

Museum Register Numbers, 3499, 3501, (=291,) 3502 (=645,) 3503.*

Lingula Hurlbuti. (*N. sp.*)

Shell ovate, broadest in the anterior half, and pointed; the sides approaching the apex with a gentle convexity; lines tangent to sides at one-third the length from the apex, form an angle of seventy-two degrees; anterior angles obsolete. The exterior surface of the shell is marked by sharply elevated concentric plications, which stand perpendicular to the shell, and on the anterior third portion five occupy the space of one line, but toward the beak they are reduced in size and increase in frequency so as to become mere striae. Where these are largest and perfectly developed, the intervening grooves are destitute of fine striations. These plications leave corresponding lines on the interior cast when the shell is exfoliated. There are no longitudinal radiations visible on the exterior, but on the cast near the front are exceedingly dim, interrupted lines visible under the lens, that possibly have the same origin, but these do not extend more than a line and a half from the front margin, and they cannot be seen even with the lens except under a favorable angle of reflected light.

The most elevated portion is at one.third the length from the beak; but the convexity of the valve is moderate and regular.

This species resembles *Lingula Daphne* (Bill,) but exceeds the greatest size of that as given by Mr. Billings (*Pal. Foss.*, p. 50,) by 2½ lines, and is wholly devoid of the fine concentric striæ of that species.

Locality and Formation. At Mantorville, in the Galena limestone, collected by N. H. Winchell.

Museum Register, Number 393.

Dedicated to Mr. W. D. Hurlbut of Rochester, Minn., one of the earliest patrons of the Geological and Natural History Survey.

* Since the above was written the same species has been published in the American Journal of Science by Mr. R. P. Whitfield, (June 1880,) and named *Lingula Elderi.* His specimens were procured for him by Dr. Elder, of Rochester, where they occur in the Trenton limestone, and exhibit so perfectly the internal markings due to the visceral and muscular structure, that Mr. Whitfield regards the speeies a true Lingula, comparing it to *Lingula anatina* (Lam.) now living. Priority of publication will require the adoption of Mr. Whitfield's name, which will hereafter be applied to it in the publications of the survey.

GENUS. **Crania.** (Retzius.)

Gen. Char.—Attached by the substance of the dorsal valve, which exhibits an irregular scar. The posterior pair of adductor muscles are larger and deeper than the anterior pair.

Crania granulosa. (*N. sp.*)

Shell small but prominently elevated at the beak; orbicular, or somewhat widened between the antero-lateral margins; no concentric striæ or undulations visible on the exterior of the shell, nor radiations; the whole surface of the dorsal valve uniformly fine-granulated, or pustulose; these granulations not disposed in any apparent order. The lower valve unknown.

Locality and Formation.—Minneapolis, in the Trenton limestone. Collected by C. L. Herrick.

Museum Number 708.

GENUS. **Orthis.** (Dalman.)

Gen. Char.—Subquadrate or rounded; hinge line rarely equalling the width of the shell; shell radiately striated or plaited; each valve with a triangular cardinal area, and a triangular foramen, generally more or less closed in one valve by a deltidium; dorsal valve with divergent short-teeth, and a simple cardinal process between them.

Orthis Minneapolis. (*N. sp.*)

Shell transversely suboval; greater diameter from nine to ten lines, but some of the smaller specimens less than seven; smaller diameter from five to seven lines, but in the smaller specimens about four; hinge-line less than the greater width of the shell, but the cardinal angles are distinct in all cases, and sometimes slightly recurved by the appression of the valves. A shallow, broad sinus depresses the front of the larger valve, which produces a marked geniculation in the front margin, and sometimes an elongation of both valves toward the front. From this sinus the outline of the shell rounds evenly to the cardinal angles. Both valves with a distinct hinge-area, that of the entering valve being about two-thirds the height of that of the receiving, both being somewhat concave transversely, and with triangular foramens. The foramen of the receiving valve is about twice as high as wide, and that of the entering is about equilateral. The beak of the larger valve is small and moderately abrupt, that of the smaller inconspicuous. Both valves are ornamented with fine radiating, striæ, which increase in number by implantation two or three

times between the beak and the margin, remaining of nearly the same size. In some specimens broad, imbricating growth-bands cross these striae near the margin. but even in well-preserved specimens, there is visible under the lens no inter-costal crenulation.

The interior of the receiving valve has two strong ridges that define the margins of the main muscular impression, descending from the cardinal processes curvingly toward the centre of the valve, and terminating, before they unite, in vanishing points at about midway between the beak and the front margin. Between these ridges, and within the area they enclose, rises suddenly in the middle of the valve a straight, sharp ridge that extends toward the front of the valve, cardinal processes tooth-like.

The interior of the entering valve is only partly known. On a single specimen only is preserved a strongly divergent small tooth, with a deep pit separating it from the cardinal area. There seem to be also three (two are preserved) main ridges radiating from the beak, two short ones from the bases of the cardinal teeth, and one longer between them. The impressions of the external radii are visible on the interior margins of both valves. This differs from *Orthis Maria*, (Billings,) which it resembles, in having the front never straight, but rather protruded at the mesial angle, and in the finer radiating striæ, which are from six to eight in one line, at the middle of the front margin, instead of from three to four.

Formation and Locality. Hudson River shales at Minneapolis, and at Fountain in Fillmore county.

Collectors. N. H. Winchell and C. L. Herrick.

Museum Register Numbers, 321, 644, and 737.

Orthis media. (*N. sp.*)

Allied to *Orthis Minneapolis*, and at first confounded with that species in the preliminary assortment, is a species that varies from it in outward characters, in having coarser striæ, (and in that respect approaching *Orthis Maria*—Billings,) there being at the front margin four or five of the radiating striæ in the space of one line, and in having a less deep mesial depression on the front of the receiving valve. Along the central portion of the entering valve is usually a flattened area that widens from the beak toward the front, terminating at the mesial angles, and the cardinal angles are sometimes reflected at their extremities. The valves are apt to be displaced and distorted, indicating an insecure dental articulation, but there has been no opportunity to examine

the interior. The triangular foramen of the receiving valve, which is open in all cases, has a height of one line, which is about one-third or one-half greater than that of the entering valve. The radiating striæ double their number in the umbonal region, by implantation, and in the same manner further increase their number near the margin of the valves. They are crossed by growth-bands toward the margin of the shell.

The transverse diameter of this shell varies from seven to nine lines; that from the beaks to the front margin from less than six to less than eight.

Formation and Locality. Hudson River shales, at Minneapolis. Collected by C. L. Herrick.

Museum Register Number 3514.

Orthis Kassubæ. (*N. sp.*)

Shell transversely oblong, with a hinge-line terminating in distinct cardinal angles, but less than the greatest transverse diameter of the shell: outline evenly rounded through the front from the cardinal angles, but having a broad, gentle inclination toward the side of the entering valve along the front margin; valves closely appressed about the free margins, but having a thickness through the umboes from $2\frac{3}{4}$ to $3\frac{1}{2}$ lines; height of the larger foramen about $\frac{1}{4}$ the length of the hinge-line, and about $\frac{1}{4}$ greater than its width at the base; cardinal areas somewhat concave, but the beaks are far separate, that of the receiving valve being less extended posteriorly than the other, though more elevated and more abrupt; the plain of the cardinal area of the entering valve, which is in the plain of the sides of the shell, forms an angle greater than 90° with that of the receiving valve.

Surface marked by fine radiating costæ which bifurcate once or twice between the beaks and the free margins, none of them running out on the hinge-line, there being from six to eight in the space of one line in the middle of the front. Interior unknown.

Locality and Formation. Minneapolis, in the Hudson river shales.

Collector. N. H. Winchell.

Museum Register Numbers, 336 and 643.

Named from Mr. Charles Kassube of Minneapolis, whose collection contains the most perfect specimen seen.

Orthis amœna. (*N. sp.*)

Shell transversely oval with a hinge line that compares to the greatest diameter about as 5 to 9. Evenly rounded from the car-

dinal extremities, which hardly disturb the symmetry of the outline, through the front margin; valves nearly equal; umbonal region of the receiving valve surrounded by a depressed or somewhat concave border, which in the front margin becomes flat or inclines toward the entering valve; the entering valve having much less marginal concavity, but being moderately and evenly convex; cardinal areas small; foramens also small; beak of the receiving valve somewhat incurved; that of the entering valve small, but abrupt and distinct; surface marked by rays which are doubled or tripled in number on the umbo, by implantation, but maintain a larger size than the rest in passing to the margins, several of which are also curved so as to run out on the hinge-line; transverse diameter 9 to 10 lines; perpendicular diameter from 7½ to 8½ lines. Interior unknown.

Locality and Formation. Spring Valley, in the Galena beds of the Hudson River Formation.

Collected by N. H. Winchell.

Museum Number 642.

Orthis circularis. (*N. sp.*)

Shell sub-circular, the greatest diameter being from just in front of one cardinal angle to the antero-lateral margin on the opposite side; hinge-line about one-half the greatest diameter; along the front margin is a very slight inclination toward the smaller valve, but the valves are otherwise uniformly convex; umbo of the receiving valve prominent and full, but the beak low and arched over the cardinal area; the other valve less elevated in the umbo, and the beak less prolonged, but slightly incurved over the hinge-line; the open foramen of the receiving valve long and narrow, with an obtuse apex, but two or three times as wide at the base as at the top; surface marked by numerous fine rays, which, bifurcating once or twice between the umbo and the free margin, are sub-equal at the middle of the front margin, and number six or seven in the space of one line, two or three curving backward from the beak and terminating on the hinge-area. These rays are crossed by fine concentric lines, only visible in fresh specimens and under a magnifier, and by distant dim growth-bands, which latter begin on the umbo; diameter about half an inch. Interior unknown.

Locality and Formation. Oxford Mills, near Canon Falls, in Goodhue county, in the Hudson River shales.

Collector. N. H. Winchell.

Museum Register Number 3515.

Orthis Charlottæ. (*N. sp.*)

Of this species the only specimen seen is a perfect receiving valve.

This valve is transversely oval, or suborbicular, with a hinge-line less than two-thirds the greatest diameter, and with inconspicuous cardinal angles; moderately and uniformly convex, but with a broad undefined flattening along the central front, which extends about one-third the distance toward the beak and insensibly passes into the general convexity; beak distinct, and elevated above the hinge-line one line and a half, making angles with the posterior third of the plain of the lateral margins, of 102° and 78°, the former being within the valve and the latter behind the cardinal area; cardinal area nearly straight, the ventral teeth forming inward projections on the hinge-line; the foramen triangular, with a width at the base nearly the same as the height; exterior marked by 22-24 coarse, undivided, rounded, radiating plications of the shell, two or three of which on each side of the beak, rather terminate, or subside, on the hinge-line; these plications crossed by imbricating growth-bands, some of which are very fine, and some coarse; the intervening inward plications being of the same width, but on the interior of the shell presenting a very different aspect, by having each a central furrow or trough and thus appearing double.

The interior of the valve shows the grooved inward plications of the shell extending, along the front, nearly half way toward the beak, along the lateral margins much less, and disappearing wholly toward the cardinal angles, but in all cases extending within the visceral area, in the form of faint ridges or striations which increase in number toward the center of the shell; brachial processes stout, trigonal, truncato-concave on their extremities; muscular impression rather narrow and small, bilobate, defined by a marginal ridge which is much more distinct posteriorly, and converging at an angle of 20°, and confluent with the brachial processes, extending to within one line of the center of the valve; adductor and divaricator scars confluent; a short, distinct, keel-like, mesial ridge extending from the sinus formed by the lobes toward the center of the general muscular scar, where it is suddenly succeeded by a central depression which contracts to the beak, bounded by distinct ridges and having a slight central elevation; ventral adjustor scars outside the brachial processes and coarsely striated transversely. Transverse diameter 11 lines, perpendicular about 10 lines.

The dorsal valve is unknown.

This species differs from *O. callactis* (Dal.) by not having both valves greatly depressed, and in having 22–24 ribs instead of 16–20.

It differs from *O. Actoniæ* (Sow.) in not having a cardinal line equal to the width of the shell, nor acute cardinal angles, nor an incurved ventral beak, nor 11–20 angular ribs.

It differs from *O. calligramma* (Dal.) in not having a prominent beak in the receiving valve incurved nearly to the level of the lateral margins. (McCoy.)

It differs from *O. flabellulum* (Sow.) in not having a flat receiving valve, and in not having the dental lamellae of the receiving valve diverging at an angle of 85°. (McCoy.)

It differs from *O. pectinella* (Conrad) in not having a flat receiving valve. (Hall.)

Mr. Salter, in the *Memoirs of the British Geological Survey*, Vol. II, part 1, p. 374, has assayed to include under the general specific name of *O. calligramma* not only the *calligramma* of Dalman, but also his *callactis*, Sowerby's *virgata* and *rustica* and *Spirifer plicatus*, Von Buch's *ovata* and *orthambonites* (after de Verneuil,) Davidson's *Walsalli* and *rigida*, and a number of species of Pander, but recognizing seven varieties. Admitting this combination, and comparing the species under consideration with his general specific description, it is found to differ from it in not having squarish ribs and square furrows equal to the ribs, nor a rhomboidal muscular impression in the ventral (receiving) valve, divided by a broad faint ridge; yet it may be that Mr. Salter's description may be legitimately modified and extended so as to cover this form also.

Locality and Formation. Minneapolis, in the Hudson River shales.

Collected by C. L. Herrick.

Museum Register Number 667.

Orthis Conradi. (*N. sp.*)

Shell having the shape and size of *Orthis disparilis* (Con.) but with a moderately convex entering valve, with from fifty to sixty fine radiating striæ on each valve, about half of which disappear before reaching the beak; foramen of the larger valve narrow, of the smaller valve triangular; surface with indistinct growth-bands, but without evident interradial crenulation; on the center of the smaller valve is a flattening that widens from the beak, and disappears before reaching the margin.

Orthis disparilis, according to Conrad's original description

(*Proc. Acad. Nat. Sci., Phil.*, 1843, *Vol. I, p.* 333,) has "about twenty-eight prominent, rounded, regular ribs," and the lesser valve slightly concave, with a depressed furrow in the middle. Prof. Hall adds to this by saying (*Pal. N. Y., Vol. I, p.* 119) the ribs are "crossed by finer, concentric, elevated lines," and that the foramen is a narrow, nearly linear slit reaching to the apex; but subsequently he and Mr. R. P. Whitfield concurred in the opinion that Conrad's *O. disparilis* is the young of *Orthis tricenaria*, (Con.) (*Pal. of Ohio, Vol. II, p.* 78), especially as they both come from the Trenton limestones of western Wisconsin; and the figures of this species in the Palæontology of New York seem to bear out this view. Mr. Billings, in the *Canadian Naturalist and Geologist* for 1859, Vol. IV, figures this species from the Chazy with a "nearly flat dorsal valve, and about twenty-eight rounded, undivided ribs." At the same time he describes from the Chazy limestone *Orthis Porcia*, which differs from *O. disparilis* "in having the radiating ridges not so strong," in its "fine, strongly imbricated, concentric striæ" and "more perpendicular area" in the receiving valve, the dorsal valve being unknown.

The species under consideration differs essentially from all the foregoing, and is certainly not the young of *Othis tricenaria*, since, although both occur at Minneapolis, this is from the Hudson River Shales, while *O. tricenaria* is found in the subcrystalline layers of the upper portion of the Trenton, usually in the from of interior casts.

Formation and Locality. Hudson River Shales at Minneapolis, and in the shales accompanying the upper portion of the Trenton at Fountain in Fillmore county.

Collectors—N. H. Winchell and C. L. Herrick.

Museum Register Numbers 651 and 789.

V.

PRELIMINARY REPORT

ON THE

GEOLOGY OF CENTRAL AND WESTERN MINNESOTA.

BY WARREN UPHAM.

The area here to be described was explored during the summer and autumn of 1879. It lies on the west side of the Mississippi river, and has this stream for its border 30 miles along the north-east side of Wright county. At Clearwater, 60 miles north-west from Saint Paul, the north-east boundary of this area leaves the river and runs west 50 miles, to the south-east corner of Pope county; whence it extends 120 miles due north, to the north-east corner of Becker county, five miles south-west from Itasca lake. The northern limit of this exploration is a line drawn from the last point 78 miles west, to the Red River of the North, which it strikes 19 miles north from Moorhead and Fargo. On the west the boundary is that of Minnesota for 130 miles, following up Red and Bois des Sioux rivers and along Traverse and Big Stone lakes. On the south-west it is the Minnesota river in its south-east course from Big Stone lake to its northward bend at Mankato, 140 miles; this limit, however, being crossed so far as to include both sides of the trough-like valley in which this river flows. Thence the border is at the east side of Le Sueur, Scott, Carver, and Wright counties; reaching 75 miles from south to north. The extreme length of this area is 250 miles, this being parallel with the upper part of the Minnesota river, its south-west boundary; while its average width is about 65 miles. It thus embraces approximately 16,000 square miles, or one-fifth of the State.

In their order from north-west to south-east, the twenty-two counties included in the field of this report, are as follows: Clay, Wilkin, Traverse, Becker, Otter Tail, and Grant, principally drained by the Red river; Big Stone, Swift, Chippewa, Renville, Nicollet, Sibley, Carver, and Scott, bordering Minnesota river; with Stevens, Douglas, Pope, and Kandiyohi, also drained in large part into this river; and Meeker, McLeod, and Wright, drained principally by the Crow river, which joins the Mississippi at Dayton. The exploration of the topography and geology of this large tract within a single year has been made possible by the similarity of contour and the great extent and depth of its drift deposits, and by the very narrow limits

within which the underlying ancient rocks are exposed. These exposures have been found, with one exception, only along the bottom of the valley of Minnesota river, and in the valleys of a few of its tributaries, near their mouths, where channels 100 to 200 feet deep have been excavated in the drift.

TOPOGRAPHY.

The greater part, probably three-fourths, of this area has a *moderately undulating surface*, which lies in broad swells of various extent, height and direction, some of them prolonged, but generally without any uniformity in trend, while others are oval or nearly round. The highest portions of adjoining undulations vary from a few rods to a half mile or more apart; and their elevation is sometimes 5 to 15 feet, again 20 to 30, or even 40 feet or more, above the depressions, to which the descent is usually by very gentle slopes. These hollows have a contour that is like that of the swells inverted, being mostly wide, and either in long and often crooked courses, of unequal depth, variously branched and connected one with another, or in basins from one to one hundred acres in extent, which have no outlet but are surrounded by land 5 feet or perhaps 10, 20, or 30 feet higher upon all sides. The small swamps which fill these depressions are called *sloughs* or *marshes*, the former name being most in use upon the prairies. Many other depressions, which differ from the foregoing only in their greater depth or area, contain bodies of water, which vary from a few hundred feet to five or ten miles in length. All these are called *lakes;* and the term *pond*, which would be applied to these in the north-eastern United States, is here restricted to reservoirs made by dams.

Glacial Origin of Superficial Deposits and Contour. The portions of the earth upon which natural lakes abound are further characterized by surface deposits of clay, sand, gravel, and boulders, mixed together in the same mass, which is called till, boulder-clay, hardpan, or unmodified drift. The rock-fragments are of very diverse material and origin, having been gathered from ledges that are in place in widely separated districts. The direction in which these boulders and pebbles have been carried is from north to south, or to the south-east or south-west, throughout the northern United States and in adjoining British territory. In these and all other drift-covered regions the bed-rocks are marked by parallel scratches and furrows, called striæ, that run in the direction in which the boulders have been transported. The glaciers of the Alps and of Greenland show us such markings and similar deposits of drift now in process of formation; and there are no other known agencies capable of producing these effects. It is therefore a necessary conclusion that the last period in the geological history of this region brought a very cold climate in which a vast ice-sheet was accumulated, each year adding something to its depth by the excess of snowfall over what could be removed by melting and evaporation. Its greatest thickness was far at the north, where the solid ice probably became several miles deep; and the pressure of this vast weight caused it to flow slowly outward in all directions from its deepest part. The superficial materials formed by decomposition of the rocks before this glacial period, were then ploughed up, mingled with large additions by erosion of the underlying ledges, and carried forward in the direction of the ice-current. It appears, also, by shells and trees found deeply buried between glacial deposits, that this very

cold period was not one unbroken reign of ice, but that this retreated and reädvanced, or was possibly at some times nearly all melted and then accumulated anew. Thus periods of ice alternated with interglacial epochs, in which animal and vegetable life spread again northward, following close upon the retreat of the ice-fields. By each new advance of the glacial sheet much of the previous surface would be ploughed up and redeposited; hence we find only few and scanty remnants of fossiliferous beds in the glacial drift. At the disappearance of the last ice-sheet these drifted materials, seldom modified by water in their deposition, formed a mantle 100 to 200 feet thick, which throughout the region here described completely covered the solid rocks.

The gently undulating contour of most of this region appears to mark areas over which the ice-sheet moved in a continuous current, and from which it disappeared by melting that was extended at the same time over a wide field. The inequalities of surface are very slight in comparison with the thickness of the drift, and the average height generally rises or falls imperceptibly, its slope being often not more than 50 or 100 feet in as many miles. These general changes in altitude, which affect the whole country and give direction to its drainage, are doubtless produced by differences in height of the bed-rock upon which the drift lies as a sheet, probably somewhat uniform in depth; but the small elevations and depressions appear to be due to the accumulation of different amounts of till in and beneath adjoining portions of the moving ice-sheet. This unequal deposition of the drift has produced the multitude of lakes which dot the map of Minnesota. The lapse of time since the ice-age has been insufficient for rains and streams to fill these basins with sediment, or to cut outlets low enough to drain them; though in many instances we can see such changes slowly going forward.

Terminal Moraine of the Ice-Sheet.—The most noticeable deposits of an alpine glacier are its terminal moraine, or the heaps of rock-fragments and detritus which it carries forward to its termination. This frontal line often remains at nearly the same place through many years or centuries. The flowing ice continues to this limit, where it is melted, and the materials which have fallen upon its surface from bordering cliffs, or which it has ploughed up from below, are here left at its end in heaps, ridges and hillocks, of very irregular contour, due to slight retreats and advances of the ice-front, and of greater amount than the deposits which appear upon the area over which it moved, exposed when any climatal change causes the glacier to retreat a considerable distance. Within the field here reported we find similar but much greater accumulations of drift which appear to have been amassed where our last ice-sheet had its termination through a long period. The only notable hills of this area are of this origin. They have no exposures of solid rock, but form part of a belt of rough and hilly drift, where steep slopes and abruptly curving and broken outlines prevail.

This series of hills and rough land extends the whole length of this area, 250 miles; and beyond these limits it appears to be of the same age with a similar belt of hilly drift which has been traced across Wisconsin in the recent geological survey of that state, where it is called the Kettle Moraine. Farther east it is probably represented by similar deposits which cross north-eastern Illinois, thence bend north-eastward into southern Michigan, again

turn to the south and east through Indiana and Ohio, appear in eastern Pennsylvania and northern New Jersey, and have been traced by the writer of this along the north shore of eastern Long Island, through southern Rhode Island, in the Elizabeth islands, and along Cape Cod to its east shore. West of Minnesota our series of hills is continuous, by a loop that reaches into northern Iowa, to the great drift-range which has been called in its south-east portion the Coteau des Prairies and farther north-west the Coteau de Missouri, extending to the North Saskatchewan river, 350 miles west of Lake Winnipeg. These morainic accumulations, traced more than half way across the continent, are thought to mark the line to which the ice-sheet advanced and where it had its termination through the principal part of the last glacial epoch. At a previous period it reached much farther south, carrying its drift somewhat beyond the Missouri river and nearly to the Ohio. The limit of the ice in this earlier epoch was 300 miles south of our terminal moraine.

Medial Moraines. Before describing these hills in Minnesota, it is needful to mention that other lines of detritus and boulders, called medial moraines, are formed by alpine glaciers wherever they meet from confluent valleys, thence flowing onward together. Series of drift-hills of like origin are associated with the terminal moraine of the continental ice-sheet, which is found to have its course in long curves, convex toward the south and joined with each other by angles that point northward. The glacial sheet is thus known to have had its front divided in vast lobes, each of which had a diverging current, directed at all sides perpendicularly toward its curved frontal moraine. North from the angle of adjoining ice-lobes their currents pushed against each other, and along this line of confluent ice-fields medial moraines were accumulated, consisting of irregular hills, ridges and mounds of drift, of the same character with those that were formed along the margin of the ice-sheet.

The moraine in western Minnesota is partly medial and partly terminal. Beginning beyond the northern limit of our exploration, its course is from the vicinity of Rice lake, near the head of the Wild Rice river, south-south-west 20 miles to the east side of White Earth lake. This portion of the moraine has hills 50 to 100 feet high seen from the top of the new school-building at the White Earth Indian Agency. About this agency the country is prominently undulating, or rolling, having its crests 30 to 40 feet above the lakes which abound. Its general height is about 1600 feet above sea, and this continues to the sources of the Mississippi, 30 miles east. In the next four miles west from White Earth the land descends about 300 feet, to an extensive undulating plain, which has its east boundary at a line running nearly due south 20 miles to the Northern Pacific railroad two miles east of Audubon. Westward this expanse, declining from 1300 to 1200 feet above sea, extends in view from the agency 25 miles, beyond which it again descends 300 feet in three or four miles to the broad lacustrine plain bordering the Red river. The course of the moraine, marked by many small hills of very irregular and broken contour, is due south for its first 30 miles from White Earth lake, passing through the townships of range 40 in Becker county. This belt is crossed by the road from White Earth to Leach lake, which is described as very rough and hilly to the headwaters of Otter Tail river, beyond which it is gently undulating for 50 miles eastward. In the western

two-thirds of Erie and Burlington (139 and 138 of range 40) these hills are finely developed; they rise 50 to 100 feet above the very numerous and irregular depressions, but the general height of the country has fallen off, so that their tops are only 1450 to 1500 feet above sea. Detroit mountain, at the north-east corner of sec. 31, Erie, is one of the highest of these hills. It lies at the west side of their principal belt, which is crossed by the roads from Detroit to Frazee City. On the north road the typical morainic contour is well seen in secs. 7, 8 and 9, Burlington. The coarse unmodified glacial drift, or till, of which our moraine for 250 miles is everywhere made, so far as observed, is here disposed in a great profusion of knolls, short ridges and hills, 20 to 50 feet high.

In Otter Tail county this morainic series continues from the north-west corner of Hobart (t. 137, r. 40,) south-south-west to Spirit lake and Lake Lida, 12 miles. It here varies from one to three miles in width. Its knolls along most of this distance rise only 25 to 50 feet, but they are much more abundant and have steeper and more broken slopes than upon adjoining areas to the east or west. At the south-east side of Lake Lida it forms a range of hills, 100 feet or more above the lake. These are conspicuously seen from the township of Maine, 10 miles south-east. From Lake Lida this moraine widens and covers the first six or seven miles east from the Pelican river, above which it rises 100 to 150 feet or more; being well exhibited for 18 miles in the east portions of Erhard's Grove, Elizabeth, and Fergus Falls. On the road from Maine to Elizabeth its hills are very numerous and irregular in outlines, short, trending from north to south more frequently than in other directions, and separated by hollows 25 to 50 feet deep. Here and for six miles southward, the contour along the Red river and about Wall lake, though within this morainic belt, has been more smoothed than its other portions, probably by floods produced at the withdrawal of the ice-sheet. At Lake Lida these hills have their tops about 1425 feet above sea; thence to the vicinity of Fergus Falls this altitude gradually diminishes to 1300, not because the hills grow smaller, but because the land on which they lie slopes in this direction.

The region west of this moraine, including the south-west corner of Becker county, the south-east part of Clay county, and the west range of townships in Otter Tail county, extending from the Northern Pacific railroad 45 miles south, and as far westward as to the lacustrine basin of the Red River valley, is mainly hilly, with the highest elevations 50 to 100 feet above the hollows. In the east part of Park (t. 138, r. 44,) and perhaps at some other localities, these hills have a typically morainic contour, being plentiful and irregular, small and steep; but generally they are massive and broadly rounded, with long gently curving slopes. Indian hill, in sec. 9, Oscar (t. 134, r. 44,) affords a fine view of part of this area and of the moraine seven miles eastward, while at the west it overlooks the plain of Wilkin county, which stretches with very slight descent 20 miles to the Red river. On the east side of the moraine the only prominent outlying hills are at the south-east corner of Hobart, where a gravelly ridge of irregular contour reaches two or three miles from north to south, its highest portion being about 150 feet above the surrounding country. These are the hills which one sees from Perham, looking north-west.

The greatest development of the moraine within the limits of Minnesota,

is in southern Otter Tail county, where it sweeps in a semicircle from Fergus Falls south-east to the south line of the county and thence east and north-east to East Leaf lake, a distance of 50 miles. In the first 20 miles, or from Fergus Falls to the north side of Lake Christina, at the north-west corner of Douglas county, it is divided into two or three belts of roughly hilly land, with intervening areas of smoother contour. At one to two miles east from Fergus Falls is a narrow belt of irregular hills and hollows, with the crests about 100 feet above the river. This series continues one to three miles wide for 15 miles south-south-east, through Dane Prairie and Tumuli, into the north-east corner of Pomme de Terre township. Next it partly bends east to the high hills north of Pelican lake, and is partly represented by the less irregular but yet prominently hilly land which lies between Pelican and Pomme de Terre lakes and continues thence a few miles farther south. In Dane Prairie and Tumuli this moraine lies at the east side of a series of lakes, of which Swan and Ten Mile lakes are the largest. Beside the latter, in secs. 27 and 34, Tumuli, the contour for a width of one-eighth to one-fourth mile is in very irregular short hills, 25 to 40 feet above the lake. Their trend, north-west to south-east, is parallel with the lake and with the course of the moraine. These small hills are exceedingly rocky with granitic and gneissic boulders of all sizes up to five or six feet in diameter, which frequently cover half of the ground for several rods distance. North-east from this typically morainic line the land for a few miles is in massive hills and swells, which rise 50 to 75 feet above intervening hollows and lakes. Its least hilly portion is St. Olaf township, which has mostly a rolling surface, in extensive swells 30 to 50 feet high. The east part of Tordenskjold is occupied by a second belt of very irregular hills, which is connected through secs. 19 and 20 and the north part of secs. 7 and 8 with the series that lies at the east side of Wall lake and the Red river, reaching north-west to the broad area of this moraine in Friberg and Elizabeth. The Tordenskjold hills are also joined from the north by another line of drift deposits, having a very rough contour in knolls, ridges and hillocks, 25 to 75 feet high, which extends ten miles with an average width of one mile, from sec. 15, Maine, south-south-east by the east side of Turtle lake. The wide moraine resulting from the union of these subordinate series continues south-east to Lake Christina. Where it is crossed by the road from Clitherall to St. Olaf, its first and highest hill is called "Dutch Bluff." At the south side of this, about 125 feet lower, is a pretty lake, half a mile long, bordered all around by morainic hills. This belt of short ridges, knolls, and hollows, has a width of three miles thence to the south-west.

The Leaf Hills. In Eagle Lake township, at the north side of Lake Christina, the last described series and that which comes from the south-west by the north side of Pelican lake, are united; and thence for the next 20 miles to the east and north-east the moraine forms a range five to three miles wide, composed of very irregular, roughly outlined hills, 100 to 300 feet high This portion of the moraine is widely known by the name *Leaf mountains* We also occasionally hear this name applied to its similar but less prominent portions in the west part of this county; and at White Earth agency I was informed that these hills in Becker county are sometimes called a branch of the Leaf mountains. Northeast of East Leaf lake, where the moraine is crossed by the road from Wadena to Otter Tail lake, its eleva-

tions rise only about 100 feet and are named *Leaf hills*; which seems a more appropriate title, and will be used in this report to include the highest part of the range. The common name has currency because they are the only hills in this part of Minnesota which are conspicuously seen at any great distance.

Heights of the Leaf hills and adjoining region are as follows: average elevation of south-eastern Otter Tail county, 1375 to 1400 feet above sea; Wadena, 1358; New York Mills, 1418; Perham, 1375; Alexandria, 1391; Evansville, 1354: Lake Christina, about 1200; St. Olaf, 1344; Turtle lake, 1331; Otter Tail and Rush lakes, about 1325; East and West Leaf lakes, about 1340; East and West Battle lakes, about 1338; Clitherall lake, 1341; Nidaros plain, south-east of last, 1450 to 1460; Dutch bluff, about 1450; Leaf hills in Eagle Lake township, 1400 to 1500; in the north-east corner of Lund and north-west edge of Millerville, Douglas county, 1500 to 1600; in Leaf Mountain township, 1550 to 1650; in the north-west part of Effington, 1600 to 1700; highest summit of the Leaf hills, thought to be in sec. 32, t. 132, r. 38, about 1750; thence for seven miles north-eastward, 1650 to 1600; depression in range crossed by head of Leaf river, about 1425; hills in next six miles north, to where the series is again crossed by this river below East Leaf lake, 1640 to 1450.

The road from Alexandria to Clitherall crosses this range in the township of Leaf Mountain. The summit of the road is near the south line of this township, about 1525 feet above sea. The top of a hill a quarter of a mile east of this and about 125 feet higher, affords a fine view of these "mountains," which westward and north-eastward rise in most tumultuous confusion 150 to 250 feet or more above the intervening depressions They are massive, though very irregular in contour, with steep slopes. No prevailing trend is noticeable. Between them are enclosed frequent lakes, which vary from a few rods to a mile in length, and one of the largest lies at the north-east foot of our hill. The material is unmodified drift, nearly like that which forms very extensive gently undulating tracts elsewhere. The principal difference is that rock-fragments, large and small, are generally more numerous upon these hills, and occasionally they occur in great abundance.

The Leaf hills are also crossed by the road that runs north-west from Parker's Prairie. In t. 132. r. 38, this road winds three or four miles among their knolls, hills and short ridges, rising about 100 feet above the land on each side. Again, in going from Otter Tail lake to Wadena, this range is encountered one to two miles north-east from East Leaf lake. Here its hillocks are only 40 to 60 feet above the hollows, and 100 to 125 feet above the lake. Their material is gravel and sand with enclosed boulders, unlike the stony and gravelly clay which makes up most of these morainic accumulations. This belt of irregular hillocks and hollows, occupying a width of about two miles, next extends in a course a little west of north 12 miles, running midway between New York Mills and Rush lake, and ends (so far as we are able to report) in hills which rise 100 feet above the general level at the south side of Pine lake.

Outlying hills west of this series occur along the south side of the Leaf lakes, where they are 50 to 75 feet high; and for two miles south from East Battle lake, above which they rise about 150 feet. On the east side of this moraine two lines of hilly and irregular contour have been noted branching

off from it. The most northern starts four miles south from the east end of East Leaf lake, and extends nearly due east through Inman and Oak Valley into the north-west township of Todd county. On the road from Wadena to Parker's Prairie this line is represented by a nearly level tract of unmodified boulder-clay, in contrast with all the rest of this road which has only stratified gravel and sand. Two miles farther east, in sec. 9, t. 133, r. 35, it rises in conspicuous hills fully 100 feet above the general level. The other series starts from the highest part of the Leaf hills, 15 miles south of Leaf lakes, and passes south-east into Douglas county. In its first few miles this range decreases in height from 200 to 75 feet. At the north line of Douglas county it divides into two divergent belts, both showing a rough and broken surface, though the hills of each are only 75 feet or less in height. One of these continues south-east and east through Spruce Hill township, beyond which it has not been traced; the other runs south-south-west to the north-west side of Lake Miltona, along the west side of Lake Ida, by Elk lake and the west part of Lake Lobster, to the conspicuous hills, about 150 feet high, at the south-west corner of Moe. Each of these belts averages about one mile wide. The latter, in its farther extent, seems to lead by a continuous course from the prominent Leaf hills to the almost equally noteworthy development of this moraine through 40 miles' distance in southern Pope and northern Kandiyohi counties.

It may be here remarked that the Leaf Hills are thought by the writer to be a terminal moraine accumulated at the north-west end of a narrow area, which was not covered by ice in this epoch, but was bordered on its north-east and south-west sides by vast lobes of the ice-sheet. This seems to be indicated by the position of angles in the moraine, with branches, which were probably medial, extending from them; as also by associated deposits of stratified drift which cover extensive areas eastward; while it is obvious that such form of the ice-sheet would correspond to that which it had at an earlier period when it reached farther and surrounded a large driftless area in front of this at the south-east. The terminal moraine formed at the ice-margin in our last glacial epoch is therefore thought to be represented by some branch extending east and south-east from the Leaf hills. That region has not yet been explored in reference to its drift formations; but it is believed that a morainic belt will be found traceable continuously to the drift-hills of Manomin, the south-west part of Ramsey county, and West Saint Paul, there crossing the Mississippi river twice and thence bending east to Lake St. Croix, beyond which its course for the next 50 miles is north-eastward as traced by Prof. Chamberlin, in the geological survey of Wisconsin.

The portion of the moraine reaching from northern Becker county to Fergus Falls or perhaps to the south line of Otter Tail county, and also that from the highest part of the Leaf hills to Pine lake, are then probably medial deposits of drift heaped where opposing ice-currents met. The terminal moraine formed at the west side of the area that is supposed not to have been covered by ice at this time, may be represented by the line of irregular low hills which runs by Lake Ida; but it seems more likely that it is found in the rolling tract, nowhere very rough and broken in outlines but rising in smooth swelling hills 50 to 75 or 100 feet high, extending from the higher hills at the south-west corner of Moe north-westward to Pelican lake and Lake Christina.

From the hills in Moe and the north-east part of Solum, lying on the north and west sides of Lake Oscar, the terminal moraine, seldom much elevated above the adjacent country, but distinguished by its irregular hills and hollows, continues with an average width of about one mile, first south-west and south 12 miles to the bridge across Chippewa river in sec. 32, Nora; then south-east, east, and east-north-east 18 miles, passing along the north side of Lake Whipple to Glenwood.

The height of Lake Whipple (also called White Bear lake) is estimated to be about 1100 feet above sea. It is situated near the center of Pope county, and is the largest lake of the county, being seven miles long with an average width of two miles. At its north side, within a half mile or so back from its shore, the very irregular bluffs of this moraine rise 150, and in a few places 200 feet. This ascent forms the margin of a gently undulating plateau which extends indefinitely northward, with an average elevation about the same as the top of these bluffs. At Glenwood the moraine bends southward around the east end of the lake, and thence it appears to be represented by prominent hills along the line between Barsness and Chippewa Falls, joining the well-marked morainic range of southern Pope county at a point 10 miles south of Glenwood. The broken bluffs bordering Lake Whipple at the north and east are thus regarded as the terminal deposits of ice which was pushed north-eastward, covering the place now occupied by this lake; but before the close of this epoch, the ice-front here retreated several miles, after which it halted, perhaps with some reädvance, forming a more conspicuous terminal moraine in Blue Mounds and Barsness, which continues thence finely developed for 40 miles to the east-south-east and east.

The township of Blue Mounds has its name from the hills of this moraine, which begins a mile north-east from the east end of Lake Emily, and extends in a range of very irregular contour, 150 to 200 feet high, or about 1250 to 1300 feet above sea, east along the south side of Signalnas creek, east-south-east through Barsness, by the north side of Woodpecker lake, and between Scandinavia lake and Chippewa Falls, and thence south-east to the south side of Lake Johanna township, where it enters Kandiyohi county. The road from the west end of Lake Whipple to Benson first crosses massively hilly land, 150 feet high, then descends about 100 feet to Signalnas creek, and next climbs about 125 feet among the picturesque ridges and hillocks of the moraine, reaching a point only 30 or 40 feet below its highest summits, which lie within one and a half miles eastward. The range here consists mainly of steep ridges of variable height and length, sometimes a half mile long, running from west to east, with many enclosed irregular hollows. The road from Glenwood to Benson also passes over high swells north of this moraine, whose short, prominent west-to-east ridges it crosses in secs. 20 and 29, Barsness. A beautiful little lake is seen here in a deep hollow of these hills below the road at its west side. Upon reaching the top of the moraine by these roads, one unexpectedly discovers yet higher land within a few miles at the south and south-west, where the north part of Langhei consists wholly of massive swells and hills, 50 to 75 feet above the enclosed depressions and lakelets. This is the highest land in Pope county, being fully 100 feet above the moraine, or 1400 feet above sea. The view from it southward and westward overlooks a gently undulating, but in the distance apparently level tract, 300 to 350 feet lower, extending to the horizon.

The western and southern part of Chippewa Falls gradually becomes more and more hilly as we approach the morainic series at the south and west sides of this township. From Pope Summit, a quarter of a mile north of the village and about 125 feet above the dam, the north-west to south-east range of the terminal moraine is seen rising to about equal height two miles farther south. At the south-west side of Lake Johanna a prominent mass of highland rises 125 feet or so above this lake. Its south-west margin, in sec. 30, descends in rough and broken morainic outlines, forming a part of this series. Here and in its farther course through Kandiyohi county, its highest points are about 1250 or 1300 feet above sea, being 75 to 100 feet above the general level. In the north part of Norway Lake and south-west part of Colfax, it forms a roughly hilly belt two to three miles wide. It is finely seen at the north side of Norway lake and Lake Andrew, where it is called the "Blue hills," or sometimes a "branch of the Rocky Mountains." Its highest knob, called Mount Tom (at south-east corner of sec. 35, Colfax,) commands a fine view. The material of this hill is coarse drift, holding occasional angular boulders up to four feet in diameter and many smaller fragments, mixed also with a large proportion of water-worn gravel. At one point 40 rods north-north-east, boulders up to six feet in diameter are very abundant. The contour here is typically morainic, in short west-to-east ridges of unequal height, very steep, especially on the south side, with correspondingly irregular hollows. Eastward this moraine forms prominent hills in the north-east part of New London and north part of Irving. These cover an area about three miles wide north of Green lake, above which they rise 100 to 150 feet. One of these hills in the south part of sec. 31, Roseville, is called "Sugarloaf Peak." At the south-east corner of Roseville this moraine is called "Cape Bad Luck." The road here climbs 100 feet over a profusion of knolls and hillocks of every form, with no prevailing trend, 25 to 50 feet high above the numerous hollows, which often hold little marshes or lakelets.

This moraine is very prominent from Blue Mounds to Cape Bad Luck, along a south-east and east course of 40 miles. Though it is well known that generally the drift was transported southward, or in some direction between south-east and south-west, it seems necessary to attribute the formation of this range to a glacial current flowing north-east. It appears to mark the north-east boundary of a vast lobe of the ice-sheet, which extended from the Leaf hills to northern Iowa and had its west side at the Coteau. The moraines of its margin were pushed forward by the diverging currents of this ice-lobe, which in approaching its edge were everywhere turned perpendicularly, or nearly so, towards its terminal line. The evidences which usually show in what direction the ice-currents moved, namely, striæ, and the parent ledges from which boulders have been derived, are wanting here, and cannot be appealed to in support of this opinion. No exposures of the underlying rocks have been found in all this region, excepting at one spot seen by Owen on the Red river, a little above Fergus Falls, and commonly along the deeply excavated valley of the Minnesota river, 40 miles south-west. The position of this valley coincides approximately with the axis of this ice-lobe, being so far removed from each of its sides that theoretically it should show no deviation from the axial current. Its striæ, observed at numerous places, all bear nearly south-east. In the absence of

these usual proofs, the reasons for our belief are the continuity of this moraine from the Leaf hills to the Coteau by a great southward loop, of which the range of drift-hills in Pope and Kandiyohi counties forms a part; the wide nearly level area of glacial drift, which is enclosed by this looped hilly belt; the occurrence of a medial moraine on the south side of the terminal in Kandiyohi county; and areas of modified drift north of this terminal moraine, sloping away from it, and thus showing that the waters discharged from the ice-sheet flowed in this direction.

The medial moraine alluded to extends from Mt. Tom four miles south-south-east; it then bends south-westward in sec. 30, New London, and is finely seen for 12 miles, passing along the north-west side of Ringo, Nevada and other lakes, to Ostlund's hill in sec. 22, Mamre. Its contour is typically uneven, being composed of a mixed variety of hillocks and short ridges with many hollows. Throughout most of its course its elevation is only 50 to 75 feet above the general level. Its highest points are the two Dovre hills, about 125 feet above adjoining lakes. The road at the south-west corner of sec. 16, Dovre, runs between these hills, which, though of little height, are yet prominent as compared with the rest of this district, so that they are conspicuously seen for several miles around. They are made of nearly the same kind of drift as Mt. Tom, but have more numerous rock-fragments, both large and small. Wherever a prevailing trend is noticeable, it is parallel, or nearly so, with the course of the series, as has been also noted respecting the terminal moraine at several places

South-eastern Pope county contains several areas of modified drift, within two or three miles north of the terminal moraine, which appear to have been deposited by floods from a melting and retreating ice-sheet. One of these areas of stratified gravel and sand forms an elevated plain a mile across at the south-east side of Lake Johanna. It is bordered on all sides by land 50 to 80 feet lower, and its southern portion is about 90 feet above the lake. It has a descending slope to the north, amounting to ten feet in its mile of extent. Another plateau of similar material, extent, height, and slope of ten feet per mile to the north, occurs on the west side of Lake Johanna; and a little farther north, in sec. 6, Lake Johanna, and sec. 1, Gilchrist, are others somewhat lower, also sloping northward. These plateaus of modified drift have steep sides and nearly or quite flat tops. The intervening tracts are gently undulating lowland, also mostly modified drift, 60 to 75 feet below these high plains. The origin of these deposits seems to have been from glacial melting, which washed away a portion of the drift material that was held in the ice-sheet, and spread it upon these areas while they were still bordered on the east and west by ice-walls. The slope proves that these waters flowed northward. As these beds lie in front of the terminal moraine, it appears that they are of slightly earlier formation, or that they belong to some time in this epoch when the ice-front advanced a few miles beyond its ordinary limits.

Another noteworthy area of modified drift occurs in Roseville, north of Cape Bad Luck. Here the terminal moraine is bordered at its north side for four miles by a flat of gravel and sand, extending from two to three miles wide to Crow River, in which distance it descends about 40 feet. This deposit was probably formed by floods, which were poured down from the ice-sheet at the same time that its terminal moraine was being accumulated.

At lower stages of these waters, as in winter, channels were cut in this plain one of these, containing a narrow lakelet, occurs close east of the school-house in sec. 22. Similar, but more extensive plains of modified drift are marked features in the topography of Long Island, Martha's Vineyard, Nantucket and Cape Cod, where they lie in front (which is there south) of terminal moraines, sloping away from them and crossed by old water-courses.

The continuation of the moraine beyond Kandiyohi county forms a wider belt of drift-hills, which seldom have the peculiarly rough and broken contour seen farther north-west. It runs through Meeker, Wright, eastern Carver and south-western Hennepin counties. On the opposite side of Minnesota river it bends south, including the north-west corner of Dakota county, the east half of Scott, western Rice and the east edge of Le Sueur county. These hills rise 40 to 100 feet, rarely more, above the intervening depressions, marshes and lakes. They are massive, with moderately steep or gentle slopes, sometimes being nearly a mile long and properly called swells because of their smoothed flowing outlines. It is also to be noted that the boundary of these morainic accumulations becomes somewhat indefinite; there is a gradual change from the slightly undulating areas at each side to rolling land, and then to hills; and these, usually with no prevailing trend, are scattered more or less thickly upon a belt 5 to 15 or even 25 miles wide. This hilly tract extends through the north edge of Meeker county, by the south side of Koronis or Cedar lake, through the north part of Manannah, and eastward includes nearly all of Forest Prairie township, Forest City, except its south-west portion, and Kingston. Farther south, much of this county is specially hilly and must be reckoned as part of this morainic belt. Of this character are Dassel and the wooded eastern portion of Darwin, Collinwood in less degree, Ellsworth in its north and west portions, Greenleaf, the north-east part of Cedar Mills, northern Danielson, south-western Litchfield and most of Acton. Hills also occur one mile north of Litchfield, and five to eight miles north-west in the wooded portion of Harvey. The same hilly land reaches also north-westward, lying at the south side of the typical moraine, and occupying through Kandiyohi and north-eastern Swift counties a width that decreases from 20 to about 5 miles. The Langhei hills, south of Blue Mounds, are the west end of this tract. These too are its only portion that rises into greater prominence than the terminal moraine. Elsewhere these hills are only 40 to 60, or occasionally, as about Swift Falls, 75 to 125 feet high. At their south-west side the land becomes gently undulating or sometimes flat, as in Lake Lillian and Cosmos, forming the margin of the monotonous expanse of nearly level unmodified glacial drift, which reaches thence 75 miles to the hilly Coteau.

In Wright county it is the shorter task to enumerate the districts which are comparatively level. Such are the east portions of South Side and French lake; south-western Corinna; Clearwater prairie, three miles long; Sanborn's or Moody's prairie and adjacent portions of Silver Creek township; and Monticello and West prairies, together six miles long and two to three miles wide. These areas, like the level tract, nine miles wide, which includes the greater part of Darwin and Litchfield in Meeker county, consist of modified drift, or beds of gravel, sand, and clay, gathered from the ice-sheet and deposited by the waters of its melting. In southern Wright county, the vicinity of Waverly, Howard Lake and Smith Lake, and most of

the townships south of the railroad, excepting Franklin in which Delano is situated, consist of nearly level or gently undulating areas of unmodified drift. The swells and hills of this county are mostly 40 to 75 feet high. In its south-east portion they rise 100 to 125 feet above Crow river. Among these hills are numerous lakes, which lie in gently sloping hollows, seldom having steep shores. The most rough and typically morainic area observed is in the south-east part of Silver Creek township, where from Silver lake to Lake Ida the contour is a multidude of small hillocks and ridges of unmodified drift, 30 to 50 feet above the hollows, with no parallelism or prevailing trend. Thence a somewhat similar formation continues five miles north to the river-road. Especially prominent hills, two miles south of Clearwater, and two miles south-east of Monticello, also deserve mention. These hills in Meeker and Wright counties vary in height, descending eastward with the general slope of the country, from 1225 to 1000 feet above sea.

Hennepin county is crossed by this belt of hills in its west and south-west portions, and they are finely exhibited about Minnetonka lake (922 feet in altitude,) above which they rise 50 to 100 feet. In Carver county the townships of Chanhassen and Laketown, the north-west part of Chaska, and northern Dahlgren, are a portion of the same belt of massive hills, with no uniformity of trends, elevated 40 to 75 feet above the hollows. A rolling surface, with swells half as high as the foregoing, continues west to Young America. The remainder of Carver county, excepting its border along the Minnesota river, is gently undulating or nearly level. All these areas are unmodified drift.

In Eden Prairie and Bloomington the moraine extends along the north side of Minnesota river, to within about eight miles south-west of Fort Snelling. The river-bluff here is 140 feet high, and at a mile or two northward these morainic hills rise 100 feet higher, their tops being 950 feet approximately above sea. South-east of the Minnesota river drift-hills, some of which attain equal or greater height, occupy Burnsville, excepting the river valley, and the west part of Lakeville, in the north-west edge of Dakota county. They also cover eastern Scott county to a meridian line drawn through Shakopee. Here these swells and hills generally rise 30 to 60 feet above the hollows, and in some districts 75 to 100 feet. They are most numerous and prominent along a south-south-west course from Burnsville to the south part of Cedar Lake township. Farther west in Scott county, the contour is moderately undulating in swells 10 to 30 feet high.

The western part of Rice county, notably its west range of townships, consists mainly of these terminal drift-deposits, often roughly hilly. In Le Sueur county they give a rolling contour to the east side of Lanesburg, to Montgomery and Kilkenny, and in less degree to Lexington, Cordova, and Elysian; while in Waterville, at the south-east corner of this county, they form hills 50 to 125 feet high south of lakes Tetonka and Sakata. This was the south-eastern limit of my exploration. The continuance of this moraine to the Coteau de Missouri has been already stated. As part of the field-work of next year, we hope to make a thorough examination of that region; and also of that lying eastward from the Leaf hills and thence south to the hills of Manomin, in which distance there seem to be reasons for believing that another terminal moraine, contemporaneous and continuous with the Leaf hills, will be found, marking the south-west limit of a lobe of the ice-

sheet that pushed outward from Lake Superior and its bordering high lands. A map of this formation will be presented in our final report.

River Systems. The drainage of the portion of Minnesota here described is not much influenced by the presence of this moraine. Its accumulations rise to great prominence only in the Leaf hills. Generally they are not more than 100 feet high, and are separated by frequent hollows, which allow a free passage to streams. In comparison with the wider areas of gently undulating land, this hilly belt is narrow; and its highest elevations are small in comparison with the greater changes of altitude which come in gradually and almost imperceptibly in traveling 100 or 200 miles, such as that which makes Douglas, Otter Tail, and Becker counties 500 to 700 feet above Minneapolis and Saint Paul. The course of the moraine coincides nearly with the watershed dividing the basin of the upper Mississippi from that of the Minnesota river; but this height of land and consequent division of drainage are probably due to the height of the underlying rocks rather than to the thickness of drift there.

The principal tributaries to the Mississippi river, flowing partly or mainly from this area, are the Crow Wing river, whose branches, Shell, Leaf, and Long Prairie rivers, drain the east portion of Becker, Otter Tail, and Douglas counties; the Sauk river, which has its headwaters in Osakis lake, and in the north-east corner of Pope county; the Clearwater river, draining north eastern Meeker and north-western Wright counties; and the Crow river, which has its waters from the east edge of Pope, eastern Kandiyohi, north-eastern Renville, Meeker, Wright, McLeod, and northwestern Carver counties. The farthest source of the Crow river, in Grove Lake, Pope county, is 90 miles from its mouth, in a direct line.

Winnipeg lake and Hudson bay receive the drainage from the north-west part of our area, by the Red River of the North, which this report, following the example of Owen, calls by this name from the mouth of Otter Tail lake. This is 42 miles east of its junction with the Bois des Sioux river at Breckenridge, where the Red river turns its course ninety degrees, thence flowing north. The Bois des Sioux, a much smaller stream, having its source in Lake Traverse, is the continuation of the nearly straight course of the Red river below this junction. The name Otter Tail river is restricted to the stream which flows to the south 50 miles from the north side of Becker county, passing through Elbow, Many Point, Height of Land, Pine, and Rush lakes, besides others of less size, and emptying into Otter Tail lake.. The principal tributaries of the Red river from this area are the Wild Rice river, one of whose sources is White Earth lake, while its south branch drains north-western Becker and north-eastern Clay counties; the Buffalo river, which drains the rest of Clay county, and has its farthest sources near the center of Becker and in north-eastern Wilkin county, and the Pelican river, which joins the Red river from the north 22 miles east of Breckenridge. The last, 45 miles long in straight line, receives the waters of many lakes, of which the largest are Detroit, Cormorant, Pelican, Lizzie, and Lida. At Fergus Falls the Red river has a descent of about 85 feet, affording very valuable water-power. The Rabbit river is a small tributary to the Bois des Sioux in southern Wilkin county; and the Mustinka river, draining western Grant, north-western Stevens, and most of Traverse county, enters Traverse lake eight miles from its outlet.

The Minnesota river receives only two large tributaries from its north side, namely, the Pomme de Terre and Chippewa rivers. The farthest sources of the former are lakes in Tordenskjold and Dane Prairie, Otter Tail county. Its course is south 75 miles, joining the Minnesota river 20 miles below Big Stone Lake. The Chippewa river, nearly parallel with this and lying 5 to 15 miles farther east, drains western Douglas, nearly all of Pope, the eastern two-thirds of Swift, and the west half of Chippewa county. The other branches of the Minnesota river within this area are small, none of them exceeding 30 miles in length, as Hawk creek, 21 miles below the Chippewa; Beaver creek, again 21 miles south-east from the last; Rush river, in southern Sibley county; Carver creek, at Carver; and, on the opposite side of the Minnesota, Le Sueur and Sand creeks, and Credit river, in Le Sueur and Scott counties.

The watersheds are mostly portions of wide gently undulating areas, interspersed with frequent lakes and sloughs, and have nothing except their slightly greater elevations to distinguish them from the basins which they divide. The erosion of the drift-sheet by drainage has been small in the north and north-east portions of this region, where the valleys, as of Pelican river, the upper part of the Red river, and the Crow river, are not generally bordered by bluffs between which the streams have excavated a passage, or by bottom-lands that have become filled with their sediment. Instead they meander among the hills and swells of the drift, often flowing through lakes, and only having occasional bluffs and alluvial lands along the lower part of their course.

Lake Agassiz. The lacustrine basin of the Red River valley, and the deeply excavated channel which holds Traverse and Big Stone lakes and the Minnesota river, present quite different and more interesting features, produced by the obstruction of drainage in its present course, while the ice-sheet, subdued by a more temperate climate, was yielding its ground between north-western Minnesota and Hudson bay. During this retreat of the ice, great quantities of water were supplied by its melting, loaded, as the modified drift shows, with a large amount of gravel, sand and clay. Wherever there was free drainage away from the ice-front, these materials were deposited in the valleys along which these floods descended toward the ocean The high water of the rivers, like that which now occurs for a few days in the freshets of spring, was thus maintained through the entire summer; and this was repeated yearly till the glacial sheet had retreated beyond their lines of watershed. The abundant supply of sediment through this time gradually lifted these floods upon the surface of thick and wide plains, sloping with the valleys. After the departure of the ice, the supply of both water and sediment was so diminished that the streams could no longer overspread these flood-plains and add to their depth, but were henceforth occupied mainly in slow excavation and removal of these deposits, leaving remnants of them as plains or terraces, often 100 to 200 feet, or more, above their present channel. The Loess bluffs bordering the Missouri river are of this origin. We have now to consider an area where such free drainage could not take place, because the descent of the land is northward, in the same direction with the retreat of the ice-sheet. As soon as this receded beyond the watershed dividing the basin of the Minnesota from that of the Red river, it is evident that a lake, fed by the glacial melting, stood at the

foot of the ice-fields, and extended northward as they withdrew along the valley of the Red river to Lake Winnipeg, filling this valley and its branches to the height of the lowest point over which an outlet could be found. Until the ice-barrier was melted upon the area now crossed by the Nelson river, thereby draining this glacial lake, its outlet was along the present course of the Minnesota river. At first its overflow was upon the nearly level undulating surface of the drift, 1100 to 1125 feet above sea, at the west side of Traverse and Big Stone counties; but in process of time this cut a channel here 100 to 150 feet deep, the highest point of which is almost exactly 1000 feet above sea.* From this outlet the Red River valley, 30 to 50 miles wide, stretches 315 miles north to Lake Winnipeg, which is 710 feet above sea. Along this entire distance there is a very uniform continuous descent of a little less than one foot per mile. The drift contained in the ice-sheet upon this area, and the silt gathered by glacial rivers from each side, were here deposited in a lake, shallow near its mouth, but becoming gradually deeper northward. At the north line of the United States, its depth was 200 feet, and at Lake Winnipeg 300 feet. Beyond our national boundary, this lake covered a larger area, varying from 100 to 200 miles in breadth at and west of Lake Winnipeg; and its total length appears to have been at least 600 miles. Because of its relation to the retreating continental ice-sheet, it is proposed to call this *Lake Agassiz*, in memory of the first prominent advocate of the theory that the drift was produced by land-ice.

The basin of Lake Agassiz, now drained in its southern portion by the Red river, has an exceedingly flat surface, sloping imperceptibly northward, as also from each side to its central line. The Red river has its course in this axial depression, where it has cut a channel 20 to 60 feet deep. It is bordered by only few and narrow areas of bottom-land, instead of which its banks usually rise steeply on one side and by moderate slopes on the other, to the lacustrine plain which thence reaches nearly level 10 to 25 miles from the river. Its tributaries cross the plain in similar channels, which, as also the Red river, have occasional gullies connected with them, dry through most of the year, varying from a few hundred feet to a mile or more in length. Between the drainage lines, areas often 5 to 15 miles wide remain unmarked by any water-courses. The highest portions of these tracts are commonly from 2 to 5 feet above the lowest. The material of the greater part of this ancient lake-bed is fine clayey silt, horizontally stratified; but at its south end, in Traverse county and the south half of Wilkin county, it is mostly unstratified boulder-clay, which differs from the rolling or undulating unmodified drift of the adjoining region only in having its surface nearly flat. Both these formations are almost impervious to water, which therefore in the rainy season fills their shallow depressions, but none of these are so deep as to form permanent lakes. Even sloughs which continue marshy through the summer are infrequent, but, where they do occur cover large areas, usually several miles in extent. In crossing the vast plain of this valley on clear days, the higher land at its sides, and the groves along

* The height of Lake Traverse, according to leveling by United States engineers, in connection with Gen. Warren's survey of the Minnesota river, is 1000 feet. This is 8 feet above Big Stone lake, from which it is separated at the lowest place by only a slight watershed, perhaps five feet above Lake Traverse. Lake Winnipeg, by the survey of the Canadian Pacific railway, is 710 feet above sea.

its rivers are first seen in the distance as if their upper edges were raised a little above the horizon, with a very narrow strip of sky below. The first appearance of the tree-tops thus somewhat resembles that of dense flocks of birds flying very low several miles away. By rising a few feet, as from the ground to a wagon, or by nearer approach, the outlines become clearly defined as a grove, with a mere line of sky beneath it. Besides this mirage, the traveller is also reminded, in the same manner as at sea, that the earth is round. The surface of the plain is seen only for a distance of three or four miles; houses and grain-stacks have their tops visible first, after which, in approaching, they gradually come into full view; and the highlands, 10 or 15 miles away, forming the side of the valley, apparently lie beyond a wide depression, like a distant high coast.

In Clay county the east side of Lake Agassiz coincided nearly with the line between ranges 45 and 46. From the north line of the county to the Northern Pacific railroad, the land rises about 300 feet in going a few miles eastward, and thence stretches away 25 miles, everywhere slightly undulating, but with little change in its general height. In southern Clay county and at the east side of Wilkin county, the east shore of this glacial lake ran a few degrees east of south, to where it crosses the line of Otter Tail county, 10 miles west of Fergus Falls. Beyond this it has a south-east course about six miles to the Red river. At its east side along this distance, the glacial drift is rolling and hilly, as already described in connection with the moraine, which in south-western Otter Tail county is only 8 to 10 miles east of this basin. From the Red river the lake shore ran southward through Western township; thence in Grant county it appears to curve to the south-east, south and south-west. It crosses the railroad about a mile north-west of Herman, and its further course is by a curve south-west, west, and north-west, passing through the south-east part of Traverse county, and coming to Lake Traverse at its bluffs on the south side of the Mustinka river. Red and Bois des Sioux rivers lie 15 to 20 miles west of this shore-line.

Beaches and deltas, as well as the change from a smoothed to an undulating surface, mark the border of this lacustrine area. At and west of Muskoda, the Northern Pacific railroad cuts through a thick and extensive deposit of sand, with beds of gravel and clay in some portions, constituting a plain one and a half miles wide. This extends two or three miles to the north, and is also represented by similar accumulations south of the Buffalo river, which here enters the area formerly covered by Lake Agassiz. These beds have their surface 1075 to 1100 feet above sea, being 100 feet below the adjoining uplands on the east, and 150 feet above the lacustrine plain, which begins two miles farther west and extends 15 miles to the Red river. They appear to be the delta brought down by the Buffalo river and spread in the side of the lake at its mouth. Since the drainage of the lake the river has excavated a large gap through this deposit. A sixth of a mile east of Muskoda station, at the east edge of the delta-plain, is a ridge of interbedded gravel and sand, 25 rods wide and 10 feet high, with its top about 1110 feet above sea. A fine section is exposed by its excavation for railroad ballast, showing the stratification to be mainly level, but inclined at the sides parallel with the gently sloping surface. This beach ridge or bar extends about a half mile from north to south. It is separated from the higher land eastward by a depression about 10 feet deep and a quarter of a mile wide. Mar-

ginal deposits of considerable extent, like the plain of Muskoda, are only found where some stream entered the lake; but beach ridges, similar to the foregoing, were noted at several places in crossing the shore-line of this lake, and, when attention is given to tracing them, will probably be found continuous through long distances. Such a ridge crosses the north line of Wilkin county near the north-west corner of sec. 4, t. 136, r. 45, extending at least one and a half miles from north to south. It was again crossed near the south-east corner of sec. 21, Western, where the road from Fergus Falls to Campbell turns from a south-west to a more nearly west course. Here the ascent from its east side is 10 feet, and the descent at the west about 20. The width of the ridge, including its slopes, is 20 or 25 rods. About a mile farther west the road crosses a second ridge of half this size, about 20 feet below the first. One and a half miles north-west from Herman is a beach-ridge 15 feet above the lacustrine plain at its north-west side. The depression south-east of it is 6 or 7 feet deep and 30 rods wide, and from this there is an ascent of about 15 feet to the plain of Herman, which was therefore above the level of the lake when this beach was formed. Three miles farther north-west (at the 183rd mile-post of the railroad) is a smaller beach-ridge. The top of this is about 1035, and of that near Herman about 1055 feet above sea. All these beaches consist of sand and water-worn gravel; and in Western and Herman it is noteworthy that all the adjoining areas are boulder clay. It is expected that a full exploration of these shore-lines will be made before the completion of this survey, so that the final report shall contain a map of this lake, so far as it lay within the limits of Minnesota.

The Outlet of Lake Agassiz. The excavation of the remarkable valley occupied by the Minnesota river was first explained in 1868 by Gen. G. K. Warren, who attributed it to the outflow from this ancient lake that filled the basin of Red river and Lake Winnipeg. This valley or channel begins at the northern part of Lake Traverse, and first extends south-west to the head of this lake, thence south-east to Mankato, and next north and north-east to the Mississippi at Fort Snelling, its length being about 250 miles. Its width varies from one to four miles, and its depth is from 100 to 225 feet. The country through which it lies, as far as to Carver, about 25 miles above its junction with the Mississippi, is a nearly level expanse of till, only moderately undulating, with no prominent hills or notable depressions, excepting this deep channel and those formed by its tributary streams. Below Carver it intersects the hilly morainic belt which has been already described. Its entire course is through a region of unmodified drift, which has no exposures of solid rock at its surface within long distances upon each side. Probably no other channel of equal extent and depth has been eroded in till upon either this or the old continent.

Bluffs in slopes from 20° to 40°, and rising 100 to 200 feet to the general level of the country, form the sides of this trough-like valley. They have been produced by the washing away of their base, leaving the upper portion to fall down and thus take its steep slopes. The river in deepening its channel has been constantly changing its course, so that its current has been turned alternately against the opposite sides of its valley, at some time undermining every portion of them. In a few places this process is still going forward, but mainly the course of the Minnesota river is in the bottom-land, which descends in gentle or often broken slopes 10 to 40 or 50 feet

within one fourth to one half mile from the foot of the bluffs; then becoming the present flood-plain, one eighth to one half mile, or rarely one mile or more. in width, with its height 5 or 10 feet above ordinary low water. Comparatively little excavation has been done by the present river. As we approach its source, it dwindles to a small stream, flowing through long lakes, and we finally pass to Lake Traverse, which empties northward; yet along the upper Minnesota and at the divide between this and Red river, this valley or channel and its enclosing bluffs are as remarkable as along the lower part of Minnesota river. It is thus clearly shown to have been the outlet of Lake Agassiz, excavated while the melting ice-sheet supplied extraordinary floods, much greater in volume than the combined waters of the Minnesota and Nelson rivers at the present time.

This valley in many places cuts through the sheet of drift, and reaches the underlying rocks, which have frequent exposures along its entire course below Big Stone lake. Their contour is much more uneven than that of the drift. In the 100 miles from Big Stone lake to Fort Ridgely the strata are metamorphic gneisses and granites, which often fill the entire vallev, one to two miles wide, rising in a profusion of knolls and hills, 50 to 100 foet above the river. The depth eroded has been limited here by the presence of these rocks, among which the river flows in a winding course, crossing them at many places in rapids or falls. From New Ulm to its mouth the river is at many places bordered by Cretaceous and Lower Silurian rocks, which are nearly level in stratification. These vary in height from a few feet to 50 or rarely 75 or 100 feet above the river. From Mankato to Ottawa the river occupies a valley cut in Shakopee limestone underlain by Jordan sandstone, which form frequent bluffs upon both sides, 50 to 75 feet high. After excavating the overlying 125 to 150 feet of till, the river here found a former valley, eroded by pre-glacial streams. Its bordering walls of rock, varying from one fourth mile to at least two miles apart, are in many portions of this distance concealed by drift, which alone forms one or both sides of the valley. The next point at which the river is seen to be enclosed by rock-walls, is in its last two miles, where it flows between bluffs of Trenton limestone underlain by St. Peter sandstone, 100 feet high, and about a mile apart. This also is a pre-glacial channel, its farther continuation being occupied by the Mississippi river. The only erosion effected by the Minnesota river here since the glacial period has been to clear away a part of the drift with which the valley was then filled. Its depth at some earlier time was much greater than now, as shown by the salt-well on the bottom-land of the Minnesota river at Belle Plaine, where 202 feet of stratified gravel, sand and clay were penetratad before reaching the rock. The bottom of the pre-glacial channel there is thus at least 175 feet lower than the mouth of the Minnesota river. The excavation of the drift down to the old rocks by the outflow from Lake Agassiz, enables us to estimate approximately the depth of the general drift-sheet upon this part of Minnesota. It probably averages about 150 feet.

Heights of the bluffs, which form the sides of this valley, composed of till enclosing layers of gravel and sand in some places, and frequently having rock at their base, are as follows, stated in feet above the lakes and river: along the south part of Lake Traverse, 100 to 125; at Brown's Valley and along Big Stone lake, mainly about 125, the highest portions reaching 150;

at Ortonville, 130; at Lac qui Parle and Montevideo, 100; at Granite Falls, 150; at Minnesota Falls, 165; thence to Redwood Falls, Fort Ridgely and New Ulm, 165 to 180; at Mankato 200 to 225; at St. Peter and Ottawa, 220 to 230; at LeSueur and Henderson, 210 to 225; at Belle Plaine and Jordan, about 230; and at Shakopee 210 to 220. The morainic hills through which this valley extends below Shakopee are 225 to 250 feet in height. The elevation of Minnesota river above the sea is given on a following page. The expanse of till through which this channel is eroded slopes from 1125 feet above sea at Big Stone lake to 975 at Mankato, in 140 miles; and thence it descends to 925 at Shakopee, in 50 miles. This channel, as far as to Mankato, lies nearly midway between the terminal moraine previously described and the Coteau des Prairies, toward each of which there is a very slight ascent, sufficient to cause drainage to follow this central line.

Lakes Traverse and Big Stone are from one to one and a half miles wide, mainly occupying the entire area between the bases of the bluffs. Lake Traverse is 23 miles long; it is mostly less than 10 feet deep, and its greatest depth probably does not reach 20 feet. Big Stone lake is 26 miles long, and its greatest depth is reported to be from 15 to 30 feet. The portion of the channel between these lakes is widely known as Brown's Valley. As we stand upon the bluffs here, looking down 125 feet on these long and narrow lakes in their trough-like valley, which extends across the five miles between them, where the basins of Hudson bay and the Gulf of Mexico are now divided, we have nearly the picture which was presented when the melting ice-sheet of British America was pouring its floods along this hollow. Then the entire extent of the valley was doubtless filled every summer by a river which covered all the present areas of flood-plain, in many places occupying as great width as these lakes.

Gen. Warren observes that Lake Traverse is probably due to a partial silting up of the channel since the outflow from the Red River basin ceased, the Minnesota river at the south having brought in sufficient alluvium to form a dam; while Big Stone lake is similarly referred to the sediment brought into the valley just below it by Whetstone river. The deep, winding channel of the Whetstone river near its mouth is quite remarkable; and its level alluvium, about 5 feet above the lake, fills the valley, a mile wide between Big Stone City and Ortonville.

Fifteen miles below Big Stone lake, the Minnesota river flows through a marshy lake four miles long and about a mile wide. This may be due to the accumulation of alluvium brought into the valley by the Pomme de Terre river, which has its mouth about two miles below. Twenty-five miles from Big Stone lake, the river enters Lac qui Parle, which extends 8 miles, with a width varying from one-half to three-fourths of a mile and a maximum depth of 12 feet. This lake, as Gen. Warren suggests, has been formed by a barrier of stratified sand and silt which the Lac qui Parle river has thrown across the valley. He also shows that Lake Pepin on the Mississippi is dammed in the same way by the sediment of the Chippewa river; and that Lake St. Croix and the last 30 miles of the Minnesota river are similarly held as level back-water by the recent deposits of the Mississippi.

All the tributaries of the Minnesota river have cut deeply into the drift, because the main valley has given them the requisite slope. The largest of these extend many miles, and have their mouths level with the bottom-land

of the Minnesota river. The bluffs of all these valleys are also everywhere seamed and gullied by frequent rills and springs, many of which flow only after rains. Few of the large inlets have any great amount of sediment deposited opposite their mouths, showing that their excavation was mostly done at the same time with that of the main valley. The short ravines are more recent in their origin, and the material that filled their place is commonly spread in fan-shaped, moderately sloping banks below their mouths, which are thus kept at a height from 30 to 40 feet above the present flood-plain. The road from Fort Ridgely to New Ulm runs along the side of the bluff at the only height where a nearly level straight course could be obtained, being just above these deposits and below the ravines.

The valleys of the Pomme de Terre and Chippewa rivers, 75 to 100 feet deep along most of their course, and one-fourth mile to one mile in width, were probably avenues of drainage from the melting ice-fields in their northward retreat. Between these rivers, in the 22 miles from Appleton to Montevideo, the glacial floods at first flowed in several channels, which are excavated 40 to 80 feet below the general level of the drift-sheet, and vary from one-eighth to one-half mile in width. One of these, starting from the bend of the Pomme de Terre river, 1½ miles east of Appleton, extends 15 miles south-east to the Chippewa river near the center of Tunsburg. This old channel is joined at Milan station by another, which branches off from the Minnesota valley, running four miles east-south-east; it is also joined at the north-west corner of Tunsburg by a very notable channel which extends eastward from the middle of Lac qui Parle. The latter channel, and its continuation in the old Pomme de Terre valley to the Chippewa river, are excavated nearly as deep as the channel occupied by the Minnesota river. Its west portion holds a marsh generally known as the "Big Slough." Lac qui Parle would have to be raised only a few feet to turn it through this deserted valley. The only other localities where we have proof that the outflow from Lake Agassiz had more than one channel are 7 and 10 miles below Big Stone lake, where isolated remnants of the general sheet of till occur south of Odessa station and again three miles south-east. Each of these former islands is about a mile long, and rises 75 feet above the surrounding low land, or nearly as high as the bluffs enclosing the valley, which here measures four miles across, having a greater width than at any other point.

ELEVATIONS.

In connection with the foregoing description of topographic features, it seems desirable to present the series of altitudes which have been determined in this region by railroad and other surveys. They are mostly copied from Prof. Winchell's first annual report as geologist of Minnesota, in which they were referred to Lake Superior as a datum, calling it 600 feet above sea. Since that publication, the researches of Messrs. Gardner and Gannett, of the U. S. Geological Survey of the Territories, have shown the height of Lake Superior to be 609.4 feet above mean tide. The correction which this requires is adopted in the following tables; and in those gathered from later reports a few other changes are made, as called for by determinations of other datum points, mainly following Gannett's *Lists of Elevations*, fourth edition. These heights are stated in feet above mean sea-level:

Northern Pacific Railroad.

Lake Superior,	609.4	Audubon,	1317
Brainerd,	1214	Lake Park,	1342
Mississippi river (bed),	1147	Hawley,	1159
Wadena,	1358	Muskoda,	1092
Leaf river (bed),	1316	Buffalo river (bed),	947
New York Mills,	1418	Glyndon,	932
Otter Tail river (bed),	1327	Moorhead,	913
Perham,	1375	Red river, low water,	851
Hobart,	1393	Red river, high water	885
Pelican river (bed)	1346	Fargo,	912
Detroit,	1371	Jamestown,	1415
Oak Lake station,	1376	Missouri river, at Bismarck,	1649

St. Paul, Minneapolis & Manitoba Railroad.

a. From St. Cloud to St. Vincent.

East Saint Cloud,	1020	Red river, at Dayton bridge,	1071
Mississippi river, low water,	962	Creek-bed near Barnesville,	997
West Saint Cloud,	1034	Track on bridge here,	1012
Osakis,	1337	Glyndon,	932
Victoria,	1375	Buffalo river, track,	928
Alexandria,	1391	Buffalo river, water,	915
Ida,	1411	Averill,	927
Chippewa river, track,	1369	Felton,	925
Chippewa river, water,	1339	Borup,	921
Evansville,	1354	Wild Rice river, track,	919
Summit, 1 m. beyond last,	1378	Wild Rice river, water,	910
Christina,	1228	Red Lake river, track,	857
St. Olaf,	1344	Red Lake river, water,	850
Summit, 2½ m. beyond last,	1366	Saint Vincent,	801
Pomme de Terre river, track,	1239	Red river, low water,	767
Pomme de Terre river, water,	1205	Red river, high water,	796

b.—From St. Paul to Breckenridge.

Saint Paul,	698.4	Benson,	1042
Minneapolis,	830	Chippewa river, track,	1030
Lake Minnetonka, water,	922	Chippewa river, water,	1021
Delano,	923	Clontarf,	1041
Waverly,	1007	Hancock,	1150
Twelve Mile Creek,	995	Summit, 1½ miles beyond last,	1167
Howard Lake sta.,	1049	Pomme de Terre river, track,	1073
Smith Lake sta.,	1049	Pomme de Terre river, water,	1062
Cokato,	1022	Morris,	1122
Darwin,	1127	Summit, 2 miles beyond last,	1151
Litchfield,	1125	Donnelly,	1121
Swede Grove,	1186	Herman,	1063
Atwater,	1207	Mustinka creek,	1021
Summit, 4½ miles beyond last,	1264	Gorton,	1017
Kandiyohi,	1216	Tintah,	991
Willmar,	1124	Campbell,	977
St. John's,	1116	Doran,	968
Kirkhoven,	1104	Breckenridge,	957
De Graff,	1056		

Hastings & Dakota Railroad.

(Corrected at and west of Shakopee to agree with the height of Minnesota river at tha place.)

Hastings,	709.4	Chaska,	740
Farmington,	900.6	Carver,	827
Prior Lake sta.,	954	Dahlgren,	994
Prior Lake, water,	914	Benton,	959
Shakopee,	768	Young America,	1002
Minnesota river, low water,	704.5	Tiger lake, water,	991
Minnesota river, high water,	731	Glencoe,	1015

Winona & St. Peter Railroad.

Winona,	652.65	Oshawa,	980
Lewiston,	1211	Nicollet,	978
Rochester,	990	Minnesota river, high water,	808
Owatonna,	1047	New Ulm,	835
Mankato,	779	Sleepy Eye,	1032
Kasota,	837	Marshall,	1173
St. Peter,	810	State line,	1475
Minnesota river, high water,	754	Summit of Coteau, 22 ms. W.,	1999

St. Paul & Sioux City Railroad.

The profile of this line, stated on p. 38 of Gannett's *Lists of Elevations*, and derived from the first annual report on the Geology of Minnesota, is 50 feet, approximately, too high, as compared with the determination of Minnesota river by the U. S. Engineer Corps.

Survey for Minnesota Northern Railroad.

Wadena,	1358	Bass lake,	1333
Pease Prairie, t. 133, r. 38,	1459	Red river at Fergus Falls,	1181
Clitherall lake,	1341	Top of dam at Pelican Rapids,	1311
Turtle lake,	1331		

Survey for Hutchinson Branch of the Minneapolis & Northwestern Railway.

Top of Watertown dam,	925	Swan lake,	1045
Ocean marsh, 7 ms. W.,	997	Crow river, low water,	1029
Winsted lake,	994	Hutchinson,	1042

Mississippi River.

Lake Itasca,	1575	Lake City, low water,	664.2
Mouth of Leech Lake river,	1356	Winona, low water,	639.9
Mouth of Sandy Lake river,	1253	La Crosse, low water,	626.3
Mouth of Crow Wing river,	1130	Dubuque, low water,	599.1
At head of Sauk Rapids,	991	Keokuk, low water of 1851,	481.8
Saint Cloud, low water,	962	Keokuk, high water of 1851,	502 5
Top of Saint Anthony's falls, low water,	800	Saint Louis, low water,	394.5
		Saint Louis, high water of 1844	435.9
One-half mile below Saint Anthony's falls, low water,	721	Cairo, ordinary low water,	291.2
		Cairo, low water of 1871,	279.3
Mouth of Minnesota river, low water,	704.4	Cairo, high water of 1867,	333
		Memphis, low water,	184
Saint Paul, low water,	685.4	Memphis, high water,	219
Saint Paul, high water,	706.4	Natchez, low water,	66
Hastings, low water,	670.5	Baton Rouge, low water,	34

Minnesota River, low-water slope.

(Levels by U. S. Engineer Corps.)

Big Stone lake,	992.80	Mankato,	765.7
Pomme de Terre river,	962.68	Saint Peter,	743.4
Lac qui Parle,	954.04	Ottawa,	736
Chippewa river,	939.84	LeSueur,	729.2
Foot of Minnesota Falls	883.14	East Henderson,	724.8
Yellow Medicine river,	875.12	Henderson,	723.4
Redwood river,	831.67	Faxon,	713.4
Fort Ridgely,	807.39	Belle Plaine,	709.8
Big Cottonwood river,	795.92	Crest of Little Rapids,	706
Judson,	773.78	Foot of Little Rapids,	704.8
South Bend,	769.2	Mouth,	704.4
Blue Earth river,	768.9		

Red River of the North.

Lake Traverse,	1000.5	Moorhead, low water,	851
Otter Tail lake,	1325	Moorhead, high water,	885
Fergus Falls,	1181	Saint Vincent, low water,	767
Dayton bridge,	1071	Saint Vincent, high water,	796
Breckenridge,	940	Lake Winnipeg,	710

The Great Lakes.

Superior,	609.40	Erie,	573.08
Michigan and Huron,	589.15	Ontario,	250

FOREST AND PRAIRIE.

A considerable part of the area included under this report is well timbered. These forests at their borders and around the few prairies which they enclose, become gradually more open with fewer and smaller trees, or form scattered groves, with intervening bushes or grass-land. The wooded part of this district is its north-east and east side, and takes in nearly all of Becker and Otter Tail counties, in which its west boundary extends from the White Earth Agency south to the Northern Pacific railroad; thence west by Audubon, and then south by Cormorant, Pelican, Lizzie and Prairie lakes; in Erhard's Grove and Elizabeth, it includes a few miles on the west side of Pelican river; and next bends south eastward, passing by the north side of Fergus Falls, to Wall lake and the north edge of St. Olaf. Through the center of Otter Tail county the woods of its east and west portions are divided by a nearly continuous belt destitute of forest, averaging about six miles wide, which reaches from Lake Christina to Clitherall, Otter Tail and Rush lakes, and onward by Perham to the North line of the county. About half of Douglas county is forest, very irregularly bounded, its south-west limit being in the vicinity of Lakes Oscar and Mary. Pope county has only scattered groves, sometimes one or two miles wide, but separated from each other by yet wider areas of prairie, which include probably nineteen-twentieths of the county. Kandiyohi county has an area of forest 15 miles long from west to east and 3 to 10 miles wide, lying north-west, north and north-east of Green lake; also, groves of small extent, found frequently on the borders of lakes in all parts of the county except its south-west quarter.

The Big Woods. In Meeker county and others at the east and south-east, a belt of timber about 45 miles wide extends nearly one hundred miles from

north to south, commonly called the "Big Woods." Like the woods of Becker, Otter Tail and Douglas counties, it is connected northward with the great forest that overspreads nearly all of northern and north-eastern Minnesota. The west border of the Big Woods crosses Meeker county in an irregular line that has frequent indentations and spurs, passing from the northwest corner of the county south-east and south by Manannah, Forest City and Darwin, to Greenleaf. This boundary between forest on the east and prairie on the west, enters McLeod county at its north-west corner, and runs south-eastward across this and Sibley counties, by Hutchinson, Glencoe, New Auburn and Arlington. Through Nicollet county the forest occupies a width of two to four miles along the west side of Minnesota river to Mankato and South Bend. It also extends in about the same amount along the north side of Minnesota river for 15 miles above Mankato; and Timber lake, 6 miles north-west from St. Peter, is bordered by broad wood lands.

East of this line, the Big woods cover all of Wright, Carver, Scott and Le Sueur counties, excepting small enclosed prairies and the bottom-lands and terraces of modified drift within the valley of the Minnesota river. Beyond South Bend the boundary of this timbered belt is a few miles outside the limit of my exploration. Prof. Winchell, in a former report, states that its course bends eastward in Blue Earth county, passing near Janesville, and about six miles north of Waseca. Thence it turns north-east to Faribault and Cannon City, from which a spur of forest reaches south along the east side of Straight river to Owatonna. The east border of the Big Woods has a nearly north course, passing from Cannon City to Northfield, Lakeville, and the west edge of Minneapolis.

Limits of Species. Many trees, shrubs and herbs that flourish northward, have their southern limit at a line north-east and north of the Big Woods; while the forest of Becker, Otter Tail and Douglas counties contains them only in its north-east part. Among these northern species are white, red and gray pines, black spruce, balsam fir, low blueberry, and cranberry. Most of these were seen in the township of Spruce Hill at the north east corner of Douglas county, which seems to be their only occurrence in that county. Thence they are found sparingly northward to the Northern Pacific railroad, beyond which are valuable pineries, beginning at New York Mills, Pine lakes, and Frazee City, and extending indefinitely to the north and north-east. None of these species are found in the Big Woods, which however contain others, as cottonwood, bitternut, wild crab-apple, and frost grape, that are rare or wanting in the northern forest.

List of Trees and Shrubs. The following species of trees and shrubs have been observed in Becker and Otter Tail counties, by Mr. R. L. Frazee, manufacturer of lumber at Frazee City, Becker county: white pine (*Pinus Strobus*, *L.*), red (commonly called Norway) pine (*P. resinosa*, *Ait.*), and gray or Banks' pine, often called "jack pine" (*P. Banksiana*, Lambert), black spruce (*Abies nigra*, Poir.), balsam fir (*Abies balsamea*, Marshall), balsam poplar (*Populus balsamifera*, L.), paper or canoe birch (*Betula papyracea*, Ait.), and beaked hazelnut (*Corylus rostrata*, Ait.), common north-east from the Northern Pacific railroad; white elm (*Ulmus Americana*, L.), bass (*Tilia Americana*, L.), sugar maple (*Acer saccharinum*, Wang.), box-elder (*Negundo aceroides*, Mœnch), black ash (*Fraxinus sambucifolia*, Lam.), bur and white oak (*Quercus macrocarpa*, Michx., and *Q. alba*, L.), ironwood (*Ostrya Vir-*

ginica, Willd.), species of willow (*Salix*), poplar or aspen (*Populus tremuloides*, Michx.), tamarack (*Larix Americana*, Michx.), prickly ash (*Zanthoxylum Americanum*, Mill.), smooth sumac (*Rhus glabra*, L.), climbing bittersweet (*Celastrus scandens*, L.), wild plum, wild red cherry and choke cherry (*Prunus Americana*, Marshall, *P. Pennsylvanica*, L., and *P. Virginiana*, L.), ninebark (*Spiræa opulifolia*, L.), raspberry and high blackberry (*Rubus strigosus*, Michx., and *R. villosus*, Ait.), thorn (*Cratægus*,) Juneberry (*Amelanchier Canadensis*, T. & G.), prickly and smooth gooseberries (*Ribes Cynosbati*, L., and *R. hirtellum*, Michx.,) black currant (*Ribes floridum*, L.), wolfberry (*Symphoricarpus occidentalis*, R. Brown), high bush cranberry (*Viburnum Opulus*, L.), and hazelnut (*Corylus Americana*, Walt.) common generally; slippery or red elm (*Ulmus fulva*, Micheli), black oak (*Q. coccinea*, var *tinctoria*), large-toothed poplar (*P. grandidentata*, Michx.), and black cherry (*P. serotina*, Ehrhart), less frequent; red oak (*Q. rubra*, L.), soft or red maple (*Acer rubrum*, L.), black raspberries (*Rubus occidentalis*, L.), and elder (*Sambucus Canadensis*, L.), scarce; cottonwood (*populus monilifera*, Ait.), seen rarely about the shores of lakes; and hackberry (*Celtis occidentalis*, L.), known only at one place, near Lake Lida.

The Big Woods are principally made up of the following species of trees: white or American elm, bass, sugar maple, black and bur oaks, butternut, slippery or red elm, soft or red maple, bitternut, white and black ash, ironwood, wild plum, Juneberry, American crab-apple, common poplar or aspen, large-toothed poplar, tamarack (in swamps), box-elder, black cherry, cottonwood (beside rivers and lakes), water beech, willows, hackberry, paper or canoe birch, white oak, and red cedar. This list, in which the arrangement is according to the estimated order of abundance, is given by Prof. Winchell for Hennepin county, in his fifth annual report, p. 142; but it appears to be applicable, with slight differences, to all other portions of the Big Woods. Everywhere through this forest the two largest and most plentiful species are elm and bass. Another list of trees and shrubs, noted in passing through these woods in Scott county, is recorded by Prof. Winchell in his second annual report, pp. 210 and 211; followed by a few additional species, as the Kentucky coffee-tree, black walnut, and yellow birch, seen in ascending the valley of the Minnesota river to Big Stone lake.

Timber is found along the Minnesota river in a nearly continuous, though often very narrow strip, bordering the river through almost its entire course; but generally leaving much of the bottom-land treeless. The bluffs on the north-east side of the river have for the most part only thin and scanty groves or scattered trees. The south-western bluffs, on the contrary, are heavily wooded through Blue Earth and Brown counties, excepting two or three miles at New Ulm. They also are frequently well timbered in Redwood and Yellow Medicine counties; but in Lac qui Parle county they are mostly treeless, and have only occasional groves. The greater abundance of timber on the south-western bluffs appears to be due to their being less exposed to the sun, and therefore more moist, than the bluffs at the opposite side of the valley. Above Montevideo the timber is mainly restricted to a narrow belt beside the river, and to tributary valleys and ravines.

About Big Stone lake, timber generally fringes the shore; occurs of larger growth in the ravines of its bluffs; and covers its islands, situated within six miles above its mouth. The speceies of trees observed by Prof. Winchell

near the foot of this lake on its north-east side, are the following in their order of abundance: white ash, bur-oak, bass, white elm, box-elder, cottonwood, hackberry, ironwood, soft maple, wild plum, slippery elm, and willow. The shrubs recorded in the same locality are grape, prickly and smooth gooseberries, wolfberry, black currant, prickly ash, red and black raspberries, elder, sweet viburnum, red-osier dogwood, climbing bittersweet, choke cherry, red and white rose, Virginia creeper, waahoo, and smooth sumac.

Red river has no timber, or very little, for twenty miles east from Breckenridge. In the ten miles next below Breckenridge, it is bordered by scattered groves of bur-oak, ash, box-elder, elm, and bass, occupying perhaps one-fourth of this distance, while small poplars and willows occasionally appear in the spaces between the groves. Farther to the north, this river is continuously fringed with timber, and its larger tributaries have their course marked in the same way. The growth of wood is here confined to the banks of the streams, which have cut hollows 20 to 40 feet deep in the broad lacustrine plain. The trees and shrubs which thus occur along the Red and Buffalo rivers in northwestern Clay county, are stated by Mr. Adam Stein, of Georgetown, to be the following: white ash, white and slippery elm, bur-oak, ironwood, poplar, box-elder, wild plum, hackberry, prickly ash, frost grape, choke cherry, red raspberry, rose, thorn, prickly and smooth goosberries, black currant, and hazelnut, more or less common; wild red cherry, Juneberry, high bush cranberry, and cottonwood, rare.

Prairies. The greater part of the region here reported is prairie. This term is commonly used to embrace all tracts destitute of trees and shrubs but well covered with grass. Groves of a few acres, or sometimes a hundred acres or more, occur here and there upon this area beside lakes, and a narrow line of timber often borders streams, as just described along the Minnesota and Red rivers; but many lakes and streams have neither bush nor tree in sight, and frequently none is visible in a view which ranges from five to ten miles in all directions. Most of these prairies have the moderately undulating contour described at the beginning of our remarks on topography. Within the area of Lake Agassiz the surface is almost absolutely level. Other portions of these prairies are quite hilly, having undulations of 100 feet or more, as from Hawley southward along the east side of the lacustrine area to Red river; thence south-east to Pelican lake and Lake Oscar; the morainic hills of Pope county; and parts of Acton, Danielson, and Greenleaf, in Meeker county. If we compare the forests with the prairies as to their prevailing contour, we find that for the most part the former are hilly and the latter gently undulating; yet much of the timbered areas, especially of the Big Woods, is only slightly uneven and occasionally quite level, while some very hilly tracts are prairies. The material of nearly all these areas is closely alike, being till or unmodified glacial drift, showing no important differences such as might cause the growth of forest in one region and of only grass and herbage in another.

The absence of trees and shrubs upon large areas, called prairies, in this and neighboring states, is generally attributed correctly to the effect of fires. Through many centuries fires have almost annually swept over these areas, generally destroying all seedling trees and shrubs, and sometimes extending the border of the prairie by adding tracts from which the forest had been

burned. Late in autumn and again in the spring the dead grass of the prairie burns very rapidly, so that a fire within a few days sometimes spreads fifty or a hundred miles. The groves that remain in the prairie region are usually in a more or less sheltered position, being on the border of lakes and streams and sometimes nearly surrounded by them; while areas that cannot be reached by fires, as islands, are almost always wooded. If fires should fail to overrun the prairies in the future, it can hardly be doubted that nearly all of them would gradually and slowly be changed to forest. Yet it does not appear that fires in forests at the West are more frequent or destructive than at the East, and our inquiry must go back a step further to ask why fires east of the Appalachian Mountains had nowhere exterminated the forest, while so extensive areas of prairie were produced by them in the West. Among the conditions which have led to this difference, we must probably place first the generally greater amount, and somewhat more equal distribution throughout the year, of rain in the eastern states.

The average growth on the dry portions of the prairies of this region would make about a half a ton of hay per acre. It affords magnificent pasturage, but the pioneer farmer gathers nearly all his hay from the frequent depressions or "sloughs," which yield twice as much as the higher land, but of somewhat inferior quality. These are marshes through the spring and early summer, but become mostly dry later in the season, so that horses can be driven across them.

The most abundant grasses found upon the prairies in the vicinity of New Ulm by Mr. B. Juni of that place, are as follows: *Andropogon furcatus*, Muhl., *Sorghum nutans*, Gray, *Bouteloua curtipendula*, Gray, and *Stipa spartea*, Trin., common on portions neither very dry nor very moist; *Andropogon scoparius*, Michx., and *Bouteloua hirsuta*, Lagasca, common on dry swells; *Spartina cynosuroides*, Willd., in sloughs, making the principal mass of their hay; *Leersia oryzoides*, Swartz, with the last; and the stout *Phragmites communis*, Trin., common on the marshy shores of lakelets. The prairies also bear a great variety of flowers. Of asters Mr. Juni finds the most common species to be *Aster surculosus.*, Michx., *A. sericeus*, Vent., and *A. Tradescanti*, L.; of golden-rod (*Solidago*), *S. Ohioensis*, Riddell, *S. Canadensis*, L., and *S. lanceolata*, L. Among the most noticeable and common plants of the prairies, besides the foregoing, are *Liatris spicata*, Willd., *Psoralea argophylla*, Pursh, *Petalostemon violaceus*, Michx., *P. candidus*, Michx., *Amorpha canescens*, Nutt., *Rosa lucida*, Ehrhart, *Campanula rotundifolia*, L., *Phlox pilosa*, L., *Gentiana crinita*, Frœl., *G. detonsa*, Fries., and *Lilium Philadelphicum*, L.

STRATIGRAPHIC GEOLOGY.

My only observations of rocks older than the drift are confined to the deep valley of the Minnesota river, the topography of which has been already described. The only other exposure of the old rocks known within this area of 16,000 square miles is recorded by Owen, and was seen in his boat journey down the Red river, at a point a little above Fergus Falls. The geology of the Minnesota valley was explored by William H. Keating in 1823; by G. W. Featherstonhaugh in 1835; and by B. F. Shumard in 1848. Soon after the establishment of the present survey, Prof. Winchell in 1873 examined this valley throughout, and his description of it, embracing also notes as to the observations of these earlier explorers, occupies pages 127 to

212 of the second annual report. This treats very fully and completely of all the rock-formations of this valley; and its conclusions have been uniformly confirmed, while indeed very little important information has been added by my journey over the same ground.

The following description of the old rocks is therefore based in large part upon Prof. Winchell's report. They are taken up in their order of age, beginning with the oldest, and including metamorphic granites and gneisses of the great series denominated Eozoic or Archæan; a conglomerate and quartzite, considered of the same age with the Potsdam sandstone; the St. Lawrence limestone, Jordan sandstone, and Shakopee limestone, belonging to the Lower Magnesian or Calciferous epoch, all these above the metamorphic rocks being of the great Lower Silurian series; and various shales, sandstones, limestones, and clays, the latter sometimes holding beds of lignite, regarded together as of Cretaceous age. The St. Peter sandstone and Trenton limestone, of the Lower Silurian series and lying next above the Shakopee limestone, occur in this valley near its mouth, but not within the limits of the counties here reported. The glacial and modified drift come last in this order, being our latest completed geological formation.

Granites and Gneisses. These are metamorphic rocks of the series called Eozoic or Archæan, the most ancient known to geology. They are doubtless an extension from the large area of these rocks in north eastern Minnesota. They are, however, generally covered by drift except in the counties which border Lake Superior, and have only few exposures in the central part of the State. The nearest of these are in the vicinity of St. Cloud, 75 miles from the Minnesota river. It has been already stated that the various rock-formations seen along this river have been uncovered by the excavation of a deep channel through the drift.

The granites and associated rocks of this valley occur frequently through a distance of 100 miles, from a point one mile below the mouth of Big Stone lake to about five miles south-east from Fort Ridgely. In the next 13 miles, no rocks older than the Cretaceous are found. Then comes the last outcrop of granite, opposite the south-east part of New Ulm, succeeded by conglomerate and quartzyte.

No rocks older than drift, excepting some Cretaceous deposits, occur in this valley along Traverse and Big Stone lakes, or in the distance between them. One mile below Big Stone lake, a coarse red granite begins and thence occupies nearly the whole valley for three miles, its highest portions rising 50 to 75 feet above the river. It again appears in low outcrops two and three miles from the last, in secs. 30 and 32, t. 121, r. 45, the first of these being on the north side of the Minnesota a little west of Stony Run, and the second on the south side at Mr. Frederick Frankhaus', a half mile west from the ford, Two to six miles south-east from the ford, in t. 120, r. 45, which extends from the mouth of Yellow Banks river to Marsh lake, similar granite, principally red or flesh-colored but in some portions light gray, forms abundant outcrops, mainly on the south side of the river, rising 50 to 75 feet in their highest portions. North of these, two ledges of this rock were noted about a mile apart, halfway between Odessa and Correll stations, the west one lying a little south of the railroad, while the east one is crossed by it. All the foregoing exposures are massive granite, containing a large proportion of feldspar to which its prevailing reddish color is due.

It is variously jointed, but does not exhibit the lamination which is generally noticeable in the south-eastward continuation of these rocks.

Gneiss has the same composition with granite, being made up of quartz, feldspar, and mica. It differs from granite in having these minerals laminated, or arranged more or less distinctly in layers. Nearly all the metamorphic rocks that remain to be described are varieties of gneiss, with which masses of granite, syenite, and hornblende schist occur rarely. For 15 miles from the upper part of Marsh lake to the middle of Lac qui Parle, we have no report of ledges. In sec. 32, t. 119, r. 42, an island of rock occurs in Lac qui Parle, and two ledges were seen across the lake on its west side. About two miles south-east, or one and a half miles above the foot of the lake, are several small and low exposures of rock, occuring at each side and also as islands. On the north-east side this is gneiss, mostly with N. E. to S. W. strike. Its dip was clearly shown at only one place, being there 75° S. E.

In the deserted channel between Lac qui Parle and the Chippewa river rock is exposed near the south-east corner of sec. 6, Tunsburg. It also occurs at the south east corner of this township, in the bottom-land on the east side of the Chippewa river, three miles above its mouth. Another low exposure is one mile west of Montevideo on the north side of the Minnesota, half way between the river and the bluff. Close south of Montevideo, a knob of gray gneiss, nearly vertical, with W. S. W strike, rises 30 feet above the bottom-land. One to two miles south-east from Montevideo are extensive outcrops of gneiss, rising 40 to 60 feet and extending one and a half miles from the river to the bluff at its north-east side. At a little lake near the river its dip is 45° S. 10°—20° E. Adjoining this, the gneiss includes a mass of hornblende schist, 20 rods long from north-west to south-east and from 20 feet to 6 rods wide. Its dip is 33° S. E. by S. At the railroad cut the rock is reddish gray gneiss, dipping 45° to 60° S. E. Two to four miles south-east from these outcrops are others of small extent, also on the north side of Minnesota river.

At Granite Falls and Minnesota Falls ledges of gneiss occur on both sides of the river, filling the valley with a multitude of knobs and short ridges 30 to 75 feet high. These rocks begin five miles above Granite Falls, near the mouth of Stony Run. Along this distance they occur principally on the south-west side. In the N. E. ¼ of sec. 24, Stony Run, the strike for an eighth of a mile is S. 80° E., the dip being 75° N. 10° E Generally, however, the strike is nearly N. E. to S. W., the dip being south-easterly. In the north-west edge of Granite Falls, the dip is 60° S. E., but more commonly it ranges between 25° and 40°. In a few places at Granite Falls it is toward the north-east or north. At Minnesota Falls it was noted in one place to be 58° S. 10° E., and near by 85° in the same direction. These are exceptions, while the prevailing inclination is toward the south-east. The strata are reddish or gray gneiss, frequently so disintegrated by the weather that its outcrops have become turfed, varying occasionally to more enduring gray and red granites. These rocks also sometimes include trap dikes, of massive, very heavy, dark green rock, as at the rapids, recently used for manufacturing, one mile above Granite Falls, where two dikes, respectively 20 and 48 feet wide, occur 54 feet apart, their course being N. E. to S. W., conformable with the strike of the rocks. Elsewhere the gneiss may include

a bed or lenticular mass of hornblende schist, as is seen at the east end of Granite Falls bridge and dam. Gray syenite, probably valuable for building and ornamental purposes, occurs about a half mile south from Minnesota Falls. A large specimen of it, elegantly polished, was shown me by Mr. Park Worden of this place. It is composed of white quartz and black hornblende, in nearly equal parts, somewhat schistose as to the direction of its grains. The trap dikes, hornblende schist, syenite and granites, are together but a small portion of these rocks which mainly are gneiss. Its outcrops from Granite Falls to one mile below Minnesota Falls are very prominent, rising in irregular and picturesque confusion throughout the entire valley, nearly two miles wide. Lower ledges continue less frequently for a mile or two beyond these.

The next outcrops noted are six miles down the river, along its portion called Patterson's Rapids, which extend, with frequent intervals of smooth current, seven miles or more, through t. 114, r. 37. The river here divides Sacred Heart on the north from Swede's Forest on the south. In the north-west corner of Swede's Forest, ledges abound for two miles, reaching 40 to 75 feet above the river. A lone school-house is situated among them, near the north-east corner of sec. 18. Half a mile west from this, the rock is reddish gray gneiss, dipping 15° N. N. W. A third of a mile west from it, are massive granite cliffs, divided by joints into nearly square blocks, 10 to 15 feet in dimension. This rock may be found valuable for quarrying. One-eighth of a mile east from the last, it is gneiss, dipping 15° S. At the east side of the school-house, it is also gneiss, dipping about 5° S.

Along the entire river-boundary between Redwood and Renville counties, a distance of 30 miles, ledges of gneiss and granite abound, in some places enclosing masses of hornblende schist. For 12 miles above Beaver Falls they fill the whole valley, occurring on each side of the river, and rising 50 to 125 feet above it. Between Beaver and Birch Cooley creeks the outcrops are mainly on the north side of the Minnesota, rising in their highest portions 100 feet above the river. Below the mouth of Birch Cooley they are mostly on the south side, occurring in great abundance for two miles above and three miles below the mouth of Wabashaw creek. The highest of these are a mile above this creek, rising 75 to 125, or perhaps 140 feet, above the river. It will be remembered that the bluffs along all this part of the valley are about 175 feet high, so that none of these ledges was visible before the surface of the drift-sheet had been considerably channelled. At Birum's mill, on the Redwood river where it enters the Minnesota valley, 1½ miles north-east from Redwood Falls, the rock is a greenish talcose quartzyte, dipping 25° S. E. One mile north-east from this, on the opposite side of the Minnesota and one fourth of a mile north of the ford, the rock is gray gneiss, weathering to reddish gray, apparently almost vertical, with its strike E. N. E. At the east side of the road this gneiss is crossed by a nearly vertical vein, 1 to 3 feet wide, of coarsely crystalline feldspar and quartz, extending within sight 50 feet. These strata are also exposed in the valley of Beaver creek one and two miles above its junction with the Minnesota valley. The Champion mill-dam at the village of Beaver Falls is nearly within the line of strike of the gneiss described north of the ford, and a similar gneiss, with nearly the same strike, is found here. Its dip is 15° S. S. E. At the dam of the O K mill, one mile north-east from the last, is an extensive exposure of

gray gneiss, also with E. N. E. strike; it is nearly vertical, or has a steep dip to the S. S. E., and in some portions is much contorted. Veins, 6 to 18 inches wide, of coarsely crystalline flesh-colored feldspar, coinciding with the strike, are common here. The valley of Birch Cooley, one mile above its entrance into that of the Minnesota, has a large exposure of granite, holding interesting veins, faulted and divided portions of which are figured in Prof. Winchell's report. One of these veins, composed of granite and four inches wide, is traceable 250 feet, running south-west.

Two miles below the mouth of Birch Cooley, a low outcrop examined on the north side of the river is granite, containing a large proportion of flesh-colored feldspar. Ledges were next seen on the north side three miles below the last, in the vicinity of the line between Birch Cooley and Camp, extending a half mile westward from Reikie and Fenske's flour mill. A small outcrop occurs five miles south-east from these, beside a small round lakelet in the bottom-land north of the river. One mile farther south-east, in the west extremity of Ridgely township, and 1½ miles west of Fort Ridgely, are the ledges which supplied the stone used in building the fort. An excavation found near the north end of the outcrop, is in porphyritic granite, which contains abundant gray feldspar crystals, ¾ to 1½ inches long and one third to two thirds as wide; it also contains occasional masses six to twelve inches long and half as wide, mostly made up of black mica in small grains. This ledge is also traversed by several flesh-colored feldspathic veins, 2 to 6 inches wide. The other rock-masses near by are mostly feldspathic granite, flesh-colored, not noticeably porphyritic. In one band here, the rock is hornblende schist and mica schist, much contorted, weathering to a very rough honey-combed surface. This band extends several rods from north to south, and dips 45° to 60° W.

Four miles below Fort Ridgely, at Little Rock creek, which is a mere rill, ledges again appear. They extend one mile from north-west to south-east, lying on the north side of the river, and rising 40 to 60 feet above it. This rock is partly gneiss, much contorted and often obscure in its lamination, and partly granite, both being flesh-colored, apparently from weathering It is abundantly jointed and seamed. The dip is not clearly exhibited. Prof. Winchell thought, from the outlines and slopes of surface, that it might be 35° or 40° to the north.

Thirteen miles of the valley next to the south-east have no rock exposures. Two small outcrops of granite follow this, lying in the bottom-land of the S. W. ¼ of sec. 27, Courtland. It is a coarse granite, the greater part of it consisting of flesh-colored feldspar. Weathering has made it very friable on the surface, but the interior is solid. This is the last occurrence of the rocks of this series seen in the Minnesota valley. It is about 300 feet west from the south end of a conglomerate outcrop, and one mile northwest from the quartzyte at Redstone.

Examination of these notes as to strike and dip shows that the axial lines of folds in these rocks run mainly from north-east to south-west. Very thorough detailed exploration would be requisite, but very probably, being confined to this narrow valley, would be insufficient to determine the position of synclinal, anticlinal and inverted axes, or to arrive at any stratigraphic divisions of the series. No quarrying of any importance has been yet undertaken in any portion of these rocks in the Minnesota valley; but

they are extensively quarried at St. Cloud, both for building and monumental stone.

Wells in Metamorphic Rocks. A well drilled for the railroad, at Herman, Grant county, passed through 124 feet of till, and then went 65 feet in rock. The first seven or eight feet of the rock was the fine grained, buff, magnesian limestone, boulders of which are common throughout northwestern Minnesota. Prof. Winchell thinks it probable that this portion was a compacted mass of boulders. This seems to be the rock which Owen observed in the bank of the Red river above Fergus Falls. His statement shows that possibly it was there only a large slab, embedded in nearly horizontal position in the bank, instead of being in place as a solid bed. This rock outcrops in the vicinity of Winnipeg, in Manitoba. The remaining 57 feet drilled in the rock was through quartzose granite, with red feldspar; white micaceous quartzyte; and mica schist of several varieties.

The section of the salt-well at Belle Plaine was as follows, in descending order: 216 feet of stratified gravels, sands, and clays, all apparently belonging to the glacial period; 16 feet of sandstone; 10 feet of ochreous shale; 176 feet of highly magnesian clays, purple and speckled with white, mostly without siliceous grains; and 292 feet of siliceous, unctuous shale, highly ferruginous, sometimes amygdaloidal, and varying to a micaceous quartzyte. From 216 to 418 feet, the strata are thought to represent the quartzyte and pipestone of Potsdam age, which outcrop near New Ulm and in Pipestone county; from 418 feet to the bottom of the well at 710, they are considered lower than the Potsdam sandstone; but the granites and gneisses lie yet deeper. No other wells in the district here reported penetrate to the metamorphic rocks.

Decomposed Gneiss and Granite. Very remarkable chemical changes have taken place in the upper portions of many of the exposures of gneiss and granite near Redwood Falls. The rock is transformed to a soft, earthy or clayey mass, resembling kaolin. It has a blue or greenish color, when freshly exposed; but when weathered, assumes a yellowish ash color, and finally becomes white and glistening. Mica scales and laminæ of quartz are generally contained in this material, and have the same arrangement as in gneiss, so that the dip can be distinctly seen. Veins of quartz or feldspar, the latter completely decomposed, and the lines of joints, are also noticeable, just as in granite or gneiss; making it evident that this substance is the result of a decay of the rocks in their original place. So far as can be judged from stream channels and other exposures, this decomposition reaches in some places to a depth of 20 or 30 feet, perhaps more. All grades of change may be found, from ledges where only here and there a few spots have been attacked and slightly decomposed, to portions where nearly every indication of its origin has been obliterated.

Before the extensive denudation of the glacial period, it is probable that all the granite and gneiss of this region were covered by a similarly decayed surface. Upon the areas where decomposed rocks still exist, the glacial ploughing was shallower than elsewhere. These beds are frequently overlain by Cretaceous deposits, and appear to have been submerged beneath a Cretaceous ocean. Prof. Winchell suggests that their decay may have taken place during this submergence, under the influence of the abundance of alkaline chemical agents held in solution by the sea in that age. Expo-

sures of these kaolinized strata are found in a ravine north of the river opposite Minnesota Falls; in the gorge of Redwood river below Redwood Falls, interesting for its grand and beautiful scenery; in many of the ledges of Minnesota valley for several miles next below, especially in exposures made by roads at the foot of the bluffs; in the valley of Birch Cooley near its mouth; and occasionally for 8 or 10 miles farther down the valley.

The Conglomerate opposite New Ulm. This outcrop is about 1000 feet long, in which distance its height rises from 10 to about 60 feet above the river. Its strike or course is N. 20° E., while the dip, measured by Prof. Winchell, is 18° E. S. E. Its greatest exposure vertically at any one place is about 20 feet. The beds vary from 1 to 6 feet in thickness. It is a massive, tough conglomerate. The pebbles in it are all more or less water-worn; they are generally abundant, often occurring nearly as thick as they could be packed. They are of all sizes up to a diameter of one foot or a little more. These pebbles are remarkable as consisting, almost without exception, of only two kinds of rock, which occur together in nearly equal abundance and dimensions. One of the two classes is apparently a jasper, usually dull red and massive, but in many of the fragments laminated, or in thin bands, which are sometimes dark, sometimes yellow; the other class is white quartz, massive, now and then containing foreign particles, and occasionally smoky in color. The origin of this conglomerate may have been from the action of sea-waves upon a coast where only these two kinds of rock were exposed. The only pebble found, which could not be referred to these classes, was a scrap of fine-grained gneiss, two inches long. Neither the granite that outcrops close at the west, nor the quartzyte that occurs upon a large area at a mile to the east, seems to be represented. The conglomerate is probably older than the quartzyte, but both are thought to come within the Potsdam epoch.

The Quartzyte at Redstone. This lies on the north-east side of the river, beginning at the Redstone railroad-bridge, and extending one mile to the east and south-east. The highest knobs of its southern part rise 100 to 125 feet above the river, while its most northern part forms a nearly level tract of about equal height, ¾ of a mile long, lying at the south side of the carriage road. The greater part of this outcrop dips northerly. South of the west railroad-cut the dip is 27° N. 10° E. At another cut, a third of a mile east from this, it is 45° N. N. E. It frequently varies as much as 10° within a few rods, and its north portion seems to be nearly level in stratification. The thickness exposed in the whole outcrop may be 250 feet. The rock is a compact hard quartzyte, of red or reddish gray color. It is variously divided by joints, and its solid masses often have a tendency to break into rhomboidal fragments. The layers are 3 to 12 inches thick, mostly without lamination at the north; but at the south-west they show fine laminæ, part of which are shale softer than the rest of the rock. At the north-west it rarely encloses small pebbles, the largest seen being three-quarters of an inch in diameter. They include only red jasper and white quartz, like those of the conglomerate just described. Stone suitable for cellar-walls and foundations is quarried from this formation.

St. Lawrence Limestone. Eleven miles south-east from the quartzyte, we find at Hebron and Judson the first exposure of the Lower Magnesian rocks within the Minnesota valley. Thence to the limit of our survey at Hamilton

these rocks occur frequently. They consist of three members, named in ascending order the St. Lawrence limestone, Jordan sandstone and Shakopee limestone, from the lowest places in this valley at which they are well exposed.

The St. Lawrence limestone at Hebron extends from Nicollet creek, the outlet of Swan lake, about 1⅛ miles eastward It rises 25 to 35 feet above the river, against which it forms a barrier, protecting a broad terrace of modified drift that lies between the limestone exposures and the foot of the bluffs. Its stratification is nearly level, the dip being about 2° to the south-east. The beds are 1 to 4 inches thick at top, where it has been affected by weathering; below they are 4 to 12 inches thick. The rock is a fine-grained compact magnesian limestone, yellowish or reddish gray, often streaked or speckled with green. Its layers are generally separated by a thin film, or sometimes by a seam ½ inch thick, of dark green crumbling sandstone. The upper part of these beds in the race-way of the Hebron stone-mill contains a layer of soft sandstone one foot thick. Several quarries are worked slightly on each side of the river.

Other exposures of this limestone in the Minnesota valley are few. It is next recognized in two low outcrops, a mile apart, at the east side of Sibley county, 30 miles from Hebron in a straight line. The first is on land of Henry Young, in the south part of sec. 13, Jessenland. The rock is yellowish buff limestone, nearly level in stratification, in layers 1 to 4 inches thick, much divided and broken by vertical and oblique seams and cracks. A half dozen kilns of lime have been burned from this rock within the past two years. The second outcrop is owned by Walter E. Doheny, and lies in the south-west corner of Faxon, only a short distance from the town line and river. Its extent, height, stratification, and jointed condition are nearly the same as in the last. It is a dull red, slightly arenaceous limestone. A quarry seven feet deep shows layers 1 to 5 inches thick, often separated by thin earthy seams.

In St. Lawrence, 10 miles north-east from the foregoing, this limestone occurs occasionally for a distance of nearly two miles, having its top about 45 feet above the river. It is nearly level in stratification, in beds from 2 to 18 inches thick. The color is buff, reddish, or yellowish gray, usually with frequent green specks. In composition it is a siliceous magnesian limestone. It has been considerably quarried, and supplies good building stone. A vertical thickness of about 15 feet is seen in quarries and natural exposures; and wells here have drilled into it 24 feet, without reaching its base.

The reference of all these outcrops to a horizon below the Jordan sandstone is based on their lithological character, and on the position and stratification of neighboring rocks belonging higher in this group. At Jordan, 3 miles east from St. Lawrence, wells encounter the St. Lawrence limestone, pinkish buff in color and very compact and hard, lying directly beneath the soft and friable Jordan sandstone. At the upper brewery the well was 12 feet deep, 10 feet in sandstone and 2 feet in limestone. The well of the lower brewery, 11 feet deep, was dug 6 feet in sandstone, and then 5 feet in this very hard limestone. Below this it was drilled 25 feet, all the way in limestone, which was thought to grow harder; its base was not reached. The limestone also occurs in the bed of Sand creek, at the pier of the private bridge in front of the lower brewery. All these exposures of St. Lawrence

limestone in the Minnesota valley probably exhibit its upper portion, and its thickness here remains undetermined. In Fillmore and Houston counties it is about 200 feet thick, forming more than half of the Lower Magnesian group.

The Jordan Sandstone. Next above the last is a coarse-grained sandstone; white or light gray, or often somewhat stained with iron-rust. It is usually soft and crumbling, so that it is readily excavated with a shovel; but some of its beds, quarried at Jordan, yield stone sufficiently durable for the construction of large mills and bridge masonry. It becomes harder upon exposure to the air, and its ledges sometimes have an indurated surface while they are quite friable within. The stratification is level or nearly so, in beds that vary from six inches to 3 feet in thickness. While each of these layers is plainly horizontal, its lamination is frequently oblique, being inclined 5° to 20°. This structure is the same with that often seen in recent sand-deposits, where the material was spread and arranged by strong currents. The direction of this inclination is variable, and seems to indicate the action of tides or waves in water of no great depth. This sandstone, however, extends over a large area, with a comparatively uniform thickness, which is 40 or 50 feet in the Minnesota valley and 25 to 40 feet in Fillmore and Houston counties.

In the vicinity of Mankato this sandstone underlies the Shakopee limestone at the quarries upon each side of the river. They also occur in the same manner, forming bluffs, at Kasota, St. Peter, Ottawa and Louisville, as will be more fully described in speaking of the limestone.

Very extensive exposures of the Jordan sandstone are seen beside the river-road in Oshawa, extending 3 miles above St. Peter. It is easily disintegrated, which often causes slightly harder layers near the top to overhang. Many excavations, used for the same purpose as cellars, have been made in these cliffs. This sandstone also forms the foot of the bluffs at the south side of a creek that enters the Minnesota at the north-east corner of Traverse township. At these places the sandstone rises 40 or 50 feet above the river, and is capped by Shakopee limestone, less conspicuously exposed.

In Lake Prairie the sandstone is seen at several places, as in a ravine crossed by the river-road nearly opposite Ottawa, and at Patrick Osborn's and Frank Linter's, within 1½ miles farther north. Its top in all these localities is about 35 feet above the river; and at Mr. Osborn's the Shakopee limestone is seen overlying it. At and near Mr. Linter's the sandstone forms three outcrops, not protected by its usual cap of limestone. The well here went through soil and drift, 5 feet; gray and white sandstone, 25 feet, sand, 10 feet, an unconsolidated layer of this stone; and white sandstone, as above, 10 feet. Water comes at the bottom, which is probably near the underlying limestone.

At Jordan this sandstone forms numerous outcrops for three-fourths of a mile along the valley of Sand creek. The St. Lawrence limestone is found beneath it here, as already described. The stratification at this place is horizontal, and the exposures are between 35 and 75 feet, approximately, above the river. Here and in several outcrops of this rock occurring within 6 miles northward in the Minnesota valley, the overlying Shakopee limestone is wanting. Four miles from Jordan, in the south edge of Louisville, are extensive exposures of the sandstone, rising about 40 feet above the river.

At the highway bridge over Van Oser's creek, these beds dip 15° W. N. W., owing to some local disturbance which does not generally affect this area. Little Rapids in the Minnesota river, one and a half miles to the west, is caused by two nearly level outcrops of this sandstone.

The Shakopee Limestone. This highest member of the Lower Magnesian group is seen at many places overlying the stratum last described. It is a magnesian limestone of buff color, often mottled in alternate red and yellow tints. The stratification is nearly level in beds from a few inches to three feet or more in thickness. In some places, as at Kasota, in the Asylum quarry at St. Peter, and at Mankato, a part of these beds are compact and supply an excellent stone for every purpose in building or monumental work; but generally this rock is much broken by little hollows and crevices, and is of unequal texture, some portions being especially sandy or coarse in grain, or having contorted and obscure lamination. It is burned extensively for lime at Mankato, Caroline station, Ottawa, Louisville and Shakopee. The only observation of any rock lying upon this limestone in the Minnesota valley is at the Asylum quarry, where Prof. Winchell found it covered by two feet of white friable sandstone, with a thin strip of green shale about midway in it. This is supposed to be the St. Peter sandstone, which is known to be next in stratigraphic order above this limestone; it may, however, be a Cretaceous deposit. The Shakopee limestone in the Minnesota valley varies in thickness from about 50 feet thus indicated here to 70 or 80 feet at Shakopee; in Fillmore county it is about 75 feet; in Wilmington, Houston county, it has been found to be 64 feet.

In Belgrade, opposite Mankato, about 40 feet of Shakopee limestone are exposed, affording valuable quarries. In a ravine about 25 rods west of the principal quarry here, the underlying Jordan sandstone is seen for 7 feet vertically, its top being about 30 feet above the river. At the quarries in the north part of Mankato, 50 feet of limestone is shown resting upon the Jordan sandstone at about 25 feet above the river. A terrace of these strata, averaging a mile in width and 75 feet in height above the river, extends thence 7 miles northward to Kasota; beyond which it is continued in decreasing height on the other side of the river through St. Peter. The railroad well at Kasota station went through drift, mostly limestone gravel, 8 feet; solid limestone, 21 feet; and sandstone, 6 feet. Here and generally in this vicinity, the base of the limestone is about 40 feet above the river; but it sinks to about half this height in going 1½ miles northward in St. Peter, between the railroad bridge and the highway-bridge.

Ottawa is situated on another terrace of Shakopee limestone underlain by Jordan sandstone. Their junction in the bluff near Charles Schwartz' lime-kiln, called White Rock bluff by Dr. Shumard, is about 45 feet above the river. The terrace generally rises 20 or 25 feet higher, which is probably the average depth of the limestone remaining here.

The next extensive exposures of the Shakopee limestone are found in Louisville, 30 miles farther down the valley. Quarries which supply good stone for foundations and bridge masonry are worked here on land of Mrs. M. A. Spencer, 1½ miles south-east from Carver. Here the limestone has a thickness of about 30 feet, and 4 feet of the Jordan sandstone is visible below it, their junction being at 12 or 15 feet above the river. This is the lowest point in the valley at which the Jordan sandstone has been seen. A terrace

of this limestone, 40 to 50 feet above the river, extends thence two miles northward. The St. Paul & Sioux City railroad is built upon this; and close at its east side another terrace, formed by the upper part of this limestone, rises 40 feet higher. A quarry in its top half supplies rock for lime-burning at a point a half mile east from the Spencer quarry. A level-topped outlier of the upper terrace occurs 50 rods south-west from these lime-kilns.

At Shakopee the limestone rises from the river's edge to a height of 50 feet, its upper 20 feet being quarried for lime. Beneath the terrace of sand and gravel at the south and south-east, commonly called "Shakopee prairie," the limestone is found at a depth of 40 or 50 feet, its top being 60 to 70 feet above the river. Water is obtained in the wells on this terrace only after drilling 60 to 80 feet in the limestone. Thus Major H. B. Strait's well, 122 feet deep, is soil and sand, 8 feet; clay, 30; limestone, 84, its last 5 feet being light gray in color; water abundant, rising 9 feet. J A. Wilder's well, 112 feet deep, is soil, 2; yellow stratified clay, 5; sand and gravel, interstratified, coarsest below, 38; hard limestone, 61; quicksand and sandstone, 2 feet, containing plenty of water, which does not rise; "flint rocks," 4 feet. These are within the incorporated limits of Shakopee. Amos Riggs' well, 1½ miles south-east from these, in the S. E. ¼ of sec. 18, Eagle Creek, is 115 feet deep, in order as follows: soil, 2; sand and fine gravel, 38; very coarse gravel, with pebbles up to 1½ feet in diameter, 10 feet; rotten sandy limestone, picked, 5 feet; limestone drilled, nearly all alike, 60; water comes abundantly at 107, not rising.

Four miles east of Shakopee, on land of Thomas Durose, sec. 3, Eagle Creek, this limestone has a low outcrop near the river, which has been slightly quarried. About six miles farther east, at Hamilton, is the lowest point at which the Shakopee limestone is seen in the Minnesota valley. Here it occurs for about 50 feet along the bottom of the raceway of Quinn Brothers' mill, at a height of 20 or 25 feet above the river. Farther east this limestone sinks below the level of the river, and the bluffs of Fort Snelling and its vicinity are composed of the overlying St. Peter sandstone capped by Trenton limestone.

It is interesting to note the nearly level position of these very ancient strata, which have scarcely suffered any disturbance since their deposition. Alternately beds of limestone and sandstone were accumulated upon the floor of the Paleozoic sea, and they have been lifted 600 to 1000 feet or more without being broken or tilted. The height above sea of the base of the Shakopee limestone where it has been observed within the Minnesota valley, is at Mankato, 780 to 795; at Kasota, about 785; at St. Peter bridge, about 760; at Ottawa, 780; and at Louisville, about 720. The distance included is 45 miles in a straight line.

The Lower Magnesian group in this valley is nearly destitute of fossils. In the Shakopee limestone, Prof. Winchell found *Orthis* at Mr. Clapp's quarry for lime-burning in the S. E. ¼ of sec. 17, Kasota; and Dr. Shumard found *Lingula Dakotaensis* and trilobite fragments at Kasota, and the same, with another species of *Lingula* and an *Orthis*, at the White Rock or Ottawa bluff. In the Jordan sandstone, Dr. Shumard found *Straparollus Minnesotensis* a mile above Traverse des Sioux and again at Kasota.

The Cretaceous. The first important exposures of Cretaceous beds found in descending the Minnesota river, are in the valley cut by the Redwood

river below Redwood Falls, where a lignitic bed of clay or shale has been explored by a drift to the distance of 40 feet. This bed varies from 7 to 2½ feet in thickness. It is a nearly black, more or less clayey deposit, and contains much lignite of two kinds, one pulverized or in small fragments, resembling charcoal, the other hard and compact, in larger lumps, appearing like cannel coal. In the bank of Crow creek, 3½ miles below Redwood Falls, beds of the same character, 4 feet or more in thickness, and containing leaf impressions, have been explored by drifting some 200 feet. They also occur and have been somewhat tested in several other ravines in that vicinity. A similar coaly layer, 1½ feet thick, has been tunnelled into 40 feet upon the east side of Fort creek, a third of a mile east of Fort Ridgely. No compact, continuous seam of coal has been yet found in any of these beds, though much search has been made. The fragments obtained are insufficient in amount to be of any practical value. They are the same with the pieces of "charcoal" and "stone coal" that are sparingly scattered in the drift throughout all south-western Minnesota, so that frequently one or two are found in digging a well. The origin of these pieces, which vary in size up to 3 or very rarely 6 inches in diameter, is from beds like the foregoing that have been ploughed up by the ice-sheet. It appears nearly certain that no workable coal deposits exist in this region.

Sandy marl, horizontally stratified, probably Cretaceous, is seen in the lower part of the bluff below the Lower Sioux Agency, three miles south-east from Crow creek. Two miles farther east, on the north side of the river, concretionary marl or limy earth, nearly white, occurs in the banks of a small creek about three-quarters of a mile from its entrance into the Minnesota valley. An overlying bed of similar material, colored and hardened by iron-rust, is exposed 18 feet vertically.

In New Ulm the grading of Third North street close north-east of the railroad, exposes Cretaceous clays. This cut is 14 feet deep and 200 feet long. Its upper 4 feet are soil and drift, containing and overspread with many boulders of granite, gneiss and schists, up to 6 feet in diameter. The remaining 10 feet are curved, contorted, and irregularly interstratified, red, yellow, green and gray clays. They are free from gravel, but contain flat, limy concretions, in some portions abundant up to one inch in diameter, and elsewhere joined in sheets a foot or less in length and a half inch or less in thickness, conforming with the stratification. These strata are eroded and covered unconformably by the drift. The terraces on which New Ulm is built have a surface of drift, mostly stratified gravel and sand, 10 to 20 feet thick; underlain by beds that are probably of Cretaceous age, consisting of fine blue clay, bedded, weathering white, 4 to 10 feet thick, and sand or fine gravel, readily crumbling and containing rounded lumps of a fine white powder, exposed 20 to 30 feet vertically. Deposits of clay, which have been much used for the manufacture of fire-bricks and pottery, occur in the banks of the Waraju or Big Cottonwood river south-west of New Ulm. These with associated sandy marl, sandstone, and thick beds of sand, are probably Cretaceous deposits. Other beds of this period, consisting of cavernous and nodular gray limestone, much of which has been burned for lime, interstratified with green and red clay and shale, occur on the north side of the river about a mile below New Ulm, being half way between the conglomerate and quartzyte, and again a mile farther south-east on the

south side. In each place these strata form a terrace about 35 feet above the river.

Eight miles below New Ulm on the north side of the river, Cretaceous sandstone has been slightly quarried on land of William Fritz, in the N. E. ¼ of sec. 16, Courtland. It lies in layers from 1 to 6 feet thick, some of which contain fragments of wood, charcoal, and angiospermous leaves. Interstratified with these layers are others, 6 inches to 3 feet thick, of white uncemented sand. Several outcrops are found here and others appear occasionally for a mile south-eastward, varying in height from 25 to 40 feet above the river. The same rock occurs again on land of Henry Greenholtz, 3 miles south-east from the last, in sec. 24, Courtland, and has been quarried a little for culverts and cellar-walls. Its outcrop is 30 rods south-east from his house, and about 35 feet above the river. There is an irregular slope at each of these localities, amounting to about 50 feet in ¼ mile or less, between the foot of the bluffs and the river.

All the strata here described and referred to the Cretaceous age, lie in a nearly horizontal position beneath the drift. They have only yielded fossils in a few places, and these have been mostly obscure plant remains and lignite. Similar formations, containing characteristic Cretaceous fossils, have a great development in the region drained by the upper Missouri river.

The Shakopee limestone at Mankato, St. Peter, and Ottawa, contains in its cavities and fissures singular deposits of greenish or bluish clay, which becomes white by exposure to the weather. At the railroad bridge across the Blue Earth river, a cut in this limestone shows hollows and crevices reaching 20 feet below the top of the rock. These cavities are water-worn, and their surface is thinly covered by iron ore, from a half inch to an inch and a half thick. Within them, after this ferruginous crust was formed, clay has been sifted and packed so as to fill irregular spaces, often several feet in diameter, enclosed and partially covered by the limestone. The clay here is greenish or bluish, weathering white, in some portions sandy, horizontally bedded, or conforming somewhat to the shape of the hollow that holds it. The quarries at St. Peter contain in clefts and water-worn cavities a similar greenish white silt, holding much sand and many angular flinty fragments. At Ottawa, John R. Clark's quarry exposes a nearly vertical seam of this clay, 1 to 2 feet wide, 6 feet deep and extending lower, seen here for 8 rods in a nearly west-to-east course. Nearly in the line of its continuation, at 25 rods farther east, the same clay was found in Charles Needham's well, in a similar seam, reaching down 15 feet in the limestone. At St. Peter and Ottawa no marks of stratification can be seen. None of these clays have yielded any fossils. Their probable origin has been shown by Prof. Winchell, who attributes them to deposition while this region was deeply covered by the Cretaceous ocean.

Glacial Drift. The presence at many points in the Minnesota valley of decomposed granite and gneiss, and of Cretaceous beds, both of which would yield readily to eroding agencies, shows that the moving ice-sheet did not everywhere plough up all the loose material under it. A considerable depth, however, has probably been removed; and these may be scanty remnants of thick beds which covered this region generally before the glacial period. More commonly the ice-sheet removed all such material, and gathered a part of its drift from the underlying solid rocks; as is shown by their being

frequently rounded, smoothed, and marked with parallel furrows and scratches, called striæ. Similarly scratched pebbles and boulders are found in the glacial drift. These were the graving tools by which the bed-rock was worn and striated. They were held firmly by being frozen in the bottom of the ice and were pushed forward by its current, which thus recorded its direction. Our observations of striæ are of course limited to the rock exposures seen along the Minnesota valley, and there many of the rocks are so disintegrated by the weather that these marks are effaced.

Courses of Striæ in the Valley of the Minnesota River,
referred to the true meridian.

Locality.	Formation.	Course.
1 to 3 miles S. E. from foot of Big Stone lake,...........	......Granite,.....	..S. E.
F. Frankhaus', S. E. ¼ of sec. 32, t. 121, r. 45,............	......Granite,.....	..S. E.
S. E. part of Granite Falls, on N. E. side of river, at several places,..	.......Gneiss,......	..S. 45° -50° E.
Beaver Falls, at dam of O K mill,.....................	.......Gneiss,......	..S. 60° E.
2 miles below Birch Cooley creek, N. W. ¼ of sec. 10, t. 112, r. 34,...	......Granite,......	..S. 60° E.
1½ miles west from Fort Ridgely,.......................	......Granite,......	..S. 60° E.
Redstone, 1½ miles S. E. from New Ulm,................	.....Quartzyte,....	..S. 25° E.
Jordan, observed at several places by Foss, Wells & Co., in quarrying and on site of their mill..................	Jordan Sandstone,	..S. E.

In the topographic description of this region it has been pointed out that this valley lies nearly midway between parallel terminal moraines, which extend from north-west to south-east, about 80 miles apart; that on the north-east reaching from the Leaf hills to Glenwood, Minnetonka lake, and Rice county, and that on the south-west being the well-known massive Coteau des Prairies. These series of drift-hills are connected by a loop that passes through Hancock, Kossuth and Palo Alto counties in northern Iowa, making a single contemporaneous series shaped like the letter **U**, and bounding the area covered by a vast lobe or tongue of the ice-sheet. Near the center of this area the glacial current, as shown by these striæ, was in the direction of its axis or south-easterly; but in approaching its margin we must suppose that it was everywhere deflected to a course nearly perpendicular to its terminal moraine. The straight trunk and divergent branches of a tree may illustrate our idea of the axial and marginal motions of the ice-fields upon this area. The terminal moraine accumulated at their border has been described under the head of topography, so far as it has yet been explored.

The most remarkable features of our glacial deposits are their great depth and extent. It has been already stated that the old rocks are almost everywhere concealed; nor are they reached by the deepest wells, which go down 75 to 250 feet without passing through the drift, except in two or three instances, upon this entire area of 16,000 square miles. Through all this part of the State the drift probably averages as deep as along the course of

Minnesota river, where a channel cut down in many places to the older rocks shows these superficial deposits to be from 100 to 200 feet thick. We are not yet able to estimate what portion of this material was here before the glacial period, in the form of decomposed and in part solid rock, Cretaceous strata, mostly unconsolidated, and the alluvium of rivers. The aggregate of these was great, but it seems probable that this thick drift-sheet includes in addition to these materials an equally large amount brought by the ice-current from areas farther north.

Till, or unmodified glacial drift, known also as hardpan or boulder-clay, consisting of clay, sand, gravel, and boulders, mixed indiscriminately together, makes up nearly the whole of this great mass of superficial deposits; excepting the lacustrine plain of the Red River valley, filled by Lake Agassiz during the retreat of the ice-sheet, and the east part of Becker and Otter Tail counties, which are mainly modified drift. Very finely pulverized rock, forming a stiff, compact, unctuous clay, is the principal ingredient of the till upon this area, whether at great depths or at the surface. The admixture of sand and gravel is somewhat variable, being often greater in the upper than in the lower part of the till. It is rarely enough to cause the side of a well or cellar to fall down at the time of excavation. Layers of sand and gravel are frequently enclosed in the till. They are commonly from a few inches to a few feet in thickness, and often are filled with water. At considerable depths the water is generally under hydrostatic pressure, which causes it to rise in wells to within 10, 20 or 30 feet below the surface, sometimes even overflowing. Thick beds of stratified gravel, sand and clay, varying from 10 to 50 or 75 feet, also occur occasionally below till, which is again found beneath them where these stratified deposits have been penetrated.

The till is also found, even where not so divided by intercalations of modified drift, to be in massive beds which differ from each other as to color, hardness, and relative proportions of clay, sand, and stones, these changes being often noticed together at a definite line. The most notable distinction in color is that the upper part of the till, to a depth that varies from 5 to 50 feet, but is most commonly between 10 and 30 feet, is yellowish, due to the influence of air and water upon the iron contained in this deposit, changing it from the protoxide state to hydrated sesquioxide. At greater depths the color is much darker and usually bluish. In a few instances a yellow bed of till is reported beneath or enclosed in the blue till. Several observations show that the yellow color of the till, in its upper portion, has been mainly produced by exposure to the weather since its formation, and was not probably occasioned by differences in the conditions of its accumulation in and beneath the ice-sheet.

Another important difference in the till is that its upper portion is more commonly softer and easily dug with a shovel, while below there is a sudden change to a hard and compact deposit, which must be picked and is often three times as expensive for excavation. There is frequently a thin layer of sand or gravel between these kinds of till, which have their division line at a depth that varies from 5 to 30 or very rarely 40 feet. Owing to the more compact and impervious character of the lower till, the change to a yellow color is usually limited to the upper till. There are instances, however,

where this weathering has not reached to the line that divides the softer from the harder till, and others where it has extended considerably lower. The probable cause of this difference in hardness was the pressure of the vast weight of the ice-sheet upon the lower till, while the upper till was contained in the ice and dropped loosely at its melting.

Again, in numerous places the upper till as here described is directly underlain by a softer till, moist and sticky, and dark bluish in color. This is usually of considerable thickness, or between 20 and 50 feet. It often encloses or is underlain by beds of water-bearing sand; but occasionally it has been penetrated and is found to lie directly upon a bed of very compact till, such as usually comes next below the upper till. In some cases this soft and moist deposit is evidently stratified clay, free from gravel or only holding here and there a stone, and all varieties appear to be found between this and an unstratified and very pebbly till; as indeed it may be that the latter in different localities shows all gradations from its occasionally very soft character, where a shovel can be easily thrust into it to the depth of a foot or more, to the hardest deposits of the lower till in which a pick can be driven only an inch or two at one blow.

The few beds found in this district which contain shells or trees that flourished in interglacial epochs, lie beneath two distinct beds of till, the lower sometimes showing its usual hard and compact character, but elsewhere being even softer than the upper till.

Excepting the division into beds as before described, the till is an entirely unstratified deposit. There has been no assortment by water of its materials, and the coarsest and finest are mingled confusedly in the same mass. Often a thickness of fifty feet or more exhibits no evidence of stratification.

Small rock-fragments, varying in size up to the dimension of six inches, are usually numerous and scattered through all parts of the till; they are, however, seldom abundant, and are sometimes so few that in well-boring none might be encountered. Boulders of larger size are less frequent, and often a well or even a railroad cut in till fails to display any of greater diameter than 2 or 3 feet. Again several may be found of various sizes up to 5 or perhaps 7 or 8 feet. They appear to be usually more numerous in the upper part of the till than below. The number of boulders over one foot in size to be found generally upon the surface varies from one or two to ten on an acre; but often they are more scarce, so that perhaps a dozen could not be gathered on a square mile. Terminal and medial moraines usually contain both small and large boulders somewhat more abundantly, and very rarely they are so plentiful as to cover half the ground; their greater numbers being the most important difference between the till forming the morainic hills and that spread in gently undulating or nearly level tracts.

The largest boulder seen in the first seven weeks of my exploration for this survey was on the hills of Langhei, the highest in Pope county. It measured 12 by 9 feet, and rose 3 feet above the surface, probably having an equal amount buried. This was the only boulder seen during this time that exceeded eight feet in diameter, though the area traversed was almost entirely till and included the Leaf hills and the continuation of this moraine for 100 miles thence to the south and south-east. Larger blocks than the foregoing were seen only in the valley of the Minnesota river, the most

notable being in Big Stone county, where two boulders, about 30 and about 20 feet in diameter, lie near the railroad between Correll and Odessa stations. Nearly all the large boulders throughout this whole region are granite or gneiss, with occasionally one of some crystalline schist or of magnesian limestone.

The thick and almost universal mantle of drift prevents a reference of the varieties of these rocks to their sources. In general, the great representation of metamorphic rocks indicates that these probably occupy the greater part of this area, extending in a wide belt from the Minnesota river to their large tract in the north-east part of the State. The limestone, belonging to a period later than that of the St. Lawrence and Shakopee limestones, quite probably occurs in place beneath the drift in the north-west part of the region here reported, as is indicated by the well already mentioned at Herman, by Owen's note of limestone on the Red river above Fergus Falls, and by the great abundance and large size of its boulders at localities near Audubon and White Earth Agency in Becker county. Northward it outcrops near Winnipeg, and many of its boulders in our drift may have been carried this distance of 200 miles or more in the ice-sheet. The proportion of limestone through the north-west part of our district averages one-tenth or less of boulders exceeding a foot in diameter, while of small pebbles it often constitutes half in bulk and more than half in number. Handfuls of pebbles taken from stratified drift at Hawley, in Clay county, showed 125 of limestone, with 70 of granites and schists; at Muskoda, they were 44 and 36; five miles north of Breckenridge, two-thirds of the pebbles in a gravel bank beside the Red river are limestone. South-eastward a less proportion of limestone is generally found, and its abundance as boulders or pebbles seems to be confined to occasional areas a few miles or less in extent.

Records of wells, noting the order, thickness, and character of the various strata passed through, have been gathered in every part of the region here reported. The total number of wells thus noted is 582. Of these 97 are in localities which showed only modified drift; about an equal number left off in the upper till, or in beds of modified drift lying below it, without going deep enough to reach the lower till; about 30 were recorded because of their sudden rise of water, or for some other reason, without obtaining any particulars as to the material penetrated; and a few were in the rock-formations of the Minnesota valley; leaving 354 wells that show both the yellow and blue tills, in which the depth of the change of color, the occurrence of intercalated layers of modified drift, and generally the relative hardness of the upper and lower tills were noted. Of the last class, 182, or more than half, found the lower till notably harder than the upper till; and of this number, 53 had a layer of sand or gravel between these beds of boulder-clay. The yellow color is almost always limited by the line or stratified beds between these tills; and where the stratified drift is wanting, a sudden and well-marked change is noticed in hardness, color, and often in material.

Soft and moist, dark bluish till, stony and unstratified, underlies the upper till in 45 instances, in 9 of them being separated from the upper till by sand and gravel from 2 inches to 4 feet thick. Two of these beds of lower till had their first few feet hard and were soft below. In 21 other instances there were found beds of more or less plainly stratified, soft, dark bluish clay, which sometimes was free from all pebbles, and elsewhere was quite

pebbly, or, though generally free from gravel, yet contained rarely stones of various sizes up to one foot in diameter. Of these 12 lay directly below the upper till, and 9 were below both this bed and another of hard and compact lower till. The thickness of these beds of till or of stratified clay varies from 5 to 65 feet; in 30 cases it exceeded 25 feet.

The average thickness of the upper till in 256 wells where it is underlain by much harder lower till, or by beds of modified drift, is 17 feet. The extremes are 3 to 5 feet and 40 feet. Examples were found where both the thinnest and thickest of its beds were underlain here by modified drift and there by typical lower till. About a quarter part of the deep wells in till found no noticeable difference between its upper and lower portions except that of color.

Water-bearing gravel and sand, lying in a nearly horizontal layer from a few inches to five feet in thickness, were found in 148 instances at depths in the lower till varying from 30 to 265 feet. The water almost always rises from these beds, sometimes very suddenly and with much force. At Audubon, in Becker county, water was struck at 60 feet, after boring through compact till, and its pressure was so great that it instantly threw up the auger and shafting, weighing 600 pounds, twenty feet, filling the boring with gravel to that height. In three minutes it rose and stood at two feet below the surface. Two wells in Hamden, a few miles to the north, about 75 and 100 feet deep, find water at the bottom which rises and permanently overflows. Other flowing wells are found in Wilkin, Traverse, Grant, Douglas and Chippewa counties. The deepest well found is that bored for the railroad at Stewart, in McLeod county, where the water rises from a depth of 265 feet and stands at 5 feet below the surface. In most places a sufficient supply of water for common needs seeps into the well from the lower part of the upper till or is furnished by springs found in thin seams of sand or gravel next below this, or within 15 or 20 feet in the lower till. The water in these wells usually rises slowly, allowing plenty of time for walling them; or often it is under no pressure, and a reservoir must be dug below its source. The experience of well-diggers frequently demonstrates that veins of gravel and sand filled with water under pressure may be quite narrow. Thus of several wells near together one only will encounter the vein, though the others go much deeper. The upward pressure and abundant supply of water, however, show that though narrow the vein is continuous through a considerable distance and descends from a higher level. It is probable that many of these courses of gravel and sand were formed by small sub-glacial streams.

Stratified beds of gravel, sand or clay were found between the upper and lower till, or lay beneath the upper till and were not passed through, in 127 wells; 77 of which showed 2 feet or less of this modified drift; 22 had between 2 and 10 feet; 7 between 10 and 20; and 21 had from 20 to 70 feet. The thickest of these beds were seldom penetrated. The west range of townships in Otter Tail county may be mentioned as a tract in which such large deposits of modified drift are frequently found under a comparatively thin surface of upper till.

Massive deposits of stratified gravel and sand in or beneath the lower till were found in 43 wells. The lower till above the modified drift in these wells averages 26 feet thick, its extremes being 5 and 53 feet. The under-

lying gravel and sand, with layers of clay in some instances, average 17 feet, and range from 5 to 70 feet in thickness.

Interglacial epochs, in which animals and plants lived upon this area, are proved by their remains preserved, evidently where they were living, in stratified beds underlain and overlain by till. Such fossiliferous beds, however, are very rarely found in this region, and the following enumeration includes all that have come to our knowledge. In sec. 30, Blakely, Scott county, W. R Salisbury's well was yellow till, 15 feet; blue till, 30 feet; and "mud, like a lake bottom," three feet, this lowest bed containing many shells, grass, and apparently grains of wild rice. In Hutchinson, 5 miles east of the village, the well at Nancy Nutt's, in S. E. ¼ of sec. 35, was upper till, 14 feet; much harder lower till, 16 feet; and gray sand, 2 feet, the last containing abundant snail-shells, like those now living in our lakes. S. D. Ross' well, ¼ mile east of this, was similar, finding at the bottom a bed of sand filled with these shells. At Olivia station, in sec. 7, Bird Island, Renville county, the well at Lincoln Brothers' mill was yellow till, picked, 10 feet; softer but more rocky blue till, 9 feet; very hard blue till, 1 foot; and quicksand, 4 feet. A log, apparently tamarack, 8 inches in diameter, with several smaller sticks and twigs, lay across this well, embedded in the top of the quicksand. They were chopped off at each side. G. W. Burch, 2 miles south-west from this, in sec. 24, Troy, found upper till, 18 feet; dry, yellow sand, 4 feet; soft blue till, 15 feet; black loam, perhaps an interglacial soil, 2 feet; and gray quicksand, 4 feet, its upper part containing a log and smaller sticks like the foregoing. Several other wells within one or two miles about Olivia show similar remains of a deeply buried tamarack swamp. At Barnesville, in Clay county, John Marth's well was till, 12 feet; then, quicksand, 1 foot, containing several sticks of tamarack up to 8 inches in diameter, lying across the well, which, together with the inflow of water, prevented farther digging. In the N. E. ¼ of sec. 28, t. 135, r. 47, Wilkin county, C. R. Gleason's well was upper till, 8 feet; gray sand, ½ inch; much harder lower till, 18 feet; underlain by sandy black mud, containing many snail-shells. The two last are within the area that was afterward covered by Lake Agassiz. All these wells found a supply of water in the beds containing the fossils and therefore stopped before reaching the till which almost certainly underlies them. The locality first mentioned, in Blakely, is just at the top of the bluffs of Minnesota river, so that the entire depth of the drift at this place, composed about wholly of till, is known to be more than three times that of the well. The drift is probably of equal thickness in the other places; and, as shown by numerous wells 125 to 265 feet deep, it is generally composed of till, enclosing occasional stratified beds. Two other instances in which shells were found by wells in till, at Stewart and near Campbell, but where nothing definite has yet been learned about them; shells found in the brick clay at Chaska overlain by till; and a tamarack swamp at Fergus Falls, buried under 12 feet of very coarse fluvial deposits, complete this list. Though these examples are few in number, they yet are regarded as undeniable evidence that animals and plants occupied the land during temperate interglacial epochs, preceded and followed by an arctic climate and ice-sheets like those now covering the interior of Greenland and the Antarctic continent. The occurrence of interglacial shells and trees in

the Red river valley appears to prove that the departure of the ice in their epoch was sufficient to allow the drainage of this valley northward.

If successive ice-sheets have thus been accumulated and pushed forward upon this area, some of them doubtless formed terminal moraines, which were afterward covered and their mounds and hills of coarsely rocky drift spread in a nearly level stratum by the more extended ice-sheet of a later epoch. Such a buried moraine is exposed by the deep channel of the upper Minnesota river. The till here is found to contain, at a depth of 40 or 50 feet below the general surface, a stratum that abounds in boulders, usually producing a narrow shelf or terrace upon the bluffs. About Correll station, in Big Stone county, this rocky layer in the till has caused an extensive plain to be left in the process of erosion, 50 feet below the top of the bluffs and about 75 feet above the river. It is everywhere plentifully strown with boulders, and in some portions these occur in heaps and patches covering half the ground. The deserted channels north-east of Lac qui Parle frequently have their bed upon this stratum of boulders. Its exposures along the Minnesota valley were seen in many places through a distance of 50 miles, extending from the Correll plain to a point three miles below the mouth of the Yellow Medicine river.

Modified Drift. In addition to the beds of modified drift enclosed in the till or lying below it, other accumulations deposited by water occur on the surface of areas which are mainly till. They consist of interstratified gravel and sand in knolls or mounds that rise 10 to 20 feet above the general level. These are seldom very numerous, and are rarely extended in ridges or in any noticeable series. Their origin, however, was probably similar to that of the gravel ridges or kames which often form long series in other drift regions, being the deposits of glacial rivers poured down from the surface of the melting ice-fields. The only place where kames of the usual type have been observed, occurring as well-marked parallel ridges of interbedded gravel and sand, is two miles south-east of Lake Johanna in Pope county. Here they are from 25 to 75 feet high, extending two miles from north to south, and the land at each side is modified drift. A less typical ridge of this kind forms the west shore of Wall lake, five miles east of Fergus Falls.

The lake deposits of the Red River valley have been partially described, and their origin treated of, in an earlier part of this report. A section of these beds at Glyndon, shown by a boring at the elevator of G. S. Barnés & Co., was soil, 3 feet; quicksand, 22 feet; dark clay, free from stones, 75 feet; very hard yellowish till, 15 feet; softer till, 10 feet. In Moorhead the well at John Erickson's brewery was light-colored clay, 20 feet; quicksand, 4 feet; blue clay, with gravel and boulders, 80 feet; underlain by sand from which water rose immediately about 80 feet. A. H. Moore's well at Fargo, within a mile west from the last, was similar, being yellow clay, 15 feet; sand, 3 feet; dark, bluish clay, 77 feet, free from pebbles, excepting in its last two feet; underlain by sand from which water rose to 7 feet below the surface. At Georgetown, 16 miles north from these, a well 80 feet deep was wholly in stratified clay, yellowish for about 10 feet at the top and dark bluish below, finding no sandy layers and no water.

The modified drift which covers the greater part of eastern Becker and Otter Tail counties is in contrast with this plain of lacustrine clay, being almost wholly sand and fine gravel, sometimes level, again moderately undulating,

and occasionally, as at Detroit, in swells and hills 25 to 40 feet high. These deposits are not often penetrated by wells, which show them to be in some places at least 80 feet deep. Southward, similar accumulations of sand and gravel are found in the east edge of Douglas and Pope counties, while eastward they have a large extent outside the limits of this report. They are believed to have been deposited by descending floods produced and freighted by a departing ice-sheet, which appears to have sloped toward this area from the west, north, and east.

Glacial melting also filled the great valleys with stratified gravel, sand and clay. Clearwater and Monticello prairies in Wright county are expansions of this glacial flood-plain of the Mississippi. Since the ice-age the river has channelled out and carried away much of these deposits, leaving remnants upon each side. At Monticello and Clearwater these plains of modified drift are 70 to 80 feet above the river. Between them and the bottomland, or flood-plain of the present time, an intermediate terrace is frequently seen. Monticello village is situated on such an area, about 35 feet above the river. Northward, at St. Cloud and Brainerd, the old flood-plain is about 60 feet high; to the southeast it descends a little faster than the river, its height being 45 feet at Dayton, and from 25 to 30 at the head of St. Anthony's falls.

The valley of the Minnesota river from Mankato to its mouth was also filled with modified drift. Its remnants include a terrace 3 miles long east and south of Kasota; the "sand prairie" about 4 miles long and averaging a mile wide, west and north of St. Peter; Le Sueur prairie, 6 miles long and from 1 to 3 miles wide, beginning east of Ottawa and reaching to Le Sueur; the plain 5 miles long and a mile wide, near the middle of which Belle Plaine is built; Spirit hill and "sand prairie," south-west and north-west of Jordan; a terrace 8 miles long and varying from a few rods to 2 miles in width, extending through San Francisco, Dahlgren, and Carver; and Shakopee prairie, 8 miles long and averaging one mile wide. The height of these plains at Kasota, St. Peter, and Le Sueur, is about 150 feet above the river; at Belle Plaine, about 135; and at Jordan, Carver, and Shakopee, about 125. Wells on the "sand prairie" near St. Peter and on Le Sueur prairie go through sand and gravel, sometimes with layers of clay, to the depth of 75 or 100 feet, finding till below. At Belle Plaine the sand and gravel are about 50 feet deep, underlain by till. Shakopee prairie has 40 or 50 feet of this modified drift, lying upon limestone. The principal remnant of these deposits seen below Shakopee was a terrace about 75 feet high, ⅛ to ⅓ mile wide, and 4 miles long, extending through Eagan in Dakota county, its north end being about 2 miles south of Fort Snelling. This valley was first excavated in till, which rises in continuous bluffs on each side 50 to 100 feet above these high plains and terraces of modified drift. It was afterward filled for 60 miles next to its mouth with fluvial deposits 75 to 150 feet thick, sloping about 2 feet per mile, through which the channel has been cut anew. Above Mankato the valley rarely shows any similar remnants of modified drift; and those which are found appear to have been part of local accumulations, rather than of a continuous flood-plain. Further remarks relating to the orgin of the modified drift in this valley are to be found in the description, under the ensuing division of this report, of the brick clays at Chaska, Carver, and Jordan.

ECONOMIC GEOLOGY.

The chief contributions to the wealth of Minnesota, derived directly from geological formations in this district, are bricks, lime, and quarried stone. Explorations made for coal, its mode of occurrence, and the improbability that it exists here in any valuable amount, have been spoken of in our account of the cretaceous strata. No ores of any practical importance have been found. The principal resources of this part of the State are the products of its invariably fertile soil, and the water-powers afforded by many of its streams, which, by using their lakes for reservoirs, may be made nearly uniform in flow throughout the year.

Bricks. Notes respecting the manufacture of bricks have been gathered wherever this work is done, and part of these are here presented. The material employed is usually stratified clay, belonging to the modified drift; sometimes along Minnesota River it is the alluvium now being deposited at every season of high water; and rarely, as at Fergus Falls, the clay used in brick-making appears to be a true till, in which portions quite free from gravel can be selected. The bricks made from the recent alluvial clay are red, but nearly all others throughout this region are cream-colored, this difference being due to the state of chemical combination assumed during the process of burning by the iron which these clays contain.

The following statements show the extent of this industry in the Valley of Minnesota River, where bricks are made at many places, among which Chaska leads with a yearly product of about seven millions. The order is that found in ascending the river.

At Shakopee, Schrœder Brothers have made bricks 4 years; annual product, 700,000, selling at $5 per M. Alluvial clay is used, with admixture of one part sand to two of clay.

At Chaska four companies are engaged in this business, all upon an area about an eighth of a mile in extent. This clay is modified drift of interglacial age. It varies from 20 to 40 feet in thickness, being underlain by sand and covered by till from 2 to 6 feet thick, holding boulders of all sizes up to 5 or 6 feet in diameter, many of which are planed and striated. This till forms the surface, 25 to 30 feet above the river. The only fossils found here were fresh-water mussel shells, which occurred in considerable numbers upon a space four rods in diameter near the middle of Gregg & Griswold's excavation, lying in the upper foot of the clay, just beneath the till. Brick-making was begun here twelve years ago, and has been steadily increasing to the present time. The first yard worked has been now owned by Gregg & Griswold six years. Their yearly product is about 2500 thousand, selling at $5 to $6 per M. From 40 to 50 men are employed for six months. Sand is mixed in varying proportions according to the quality of the clay, the average being about one part in ten. This company have machinery and room to make 40 thousand bricks daily. L. Warner makes about two millions yearly, employing 30 men. The proportion of sand used is from one-fourth to one-seventh. Wiest & Kruze make 1500 thousand yearly, having 20 men. The two last yards have been operated about 8 years. Schlafle, Strobach & Streissguth began three years ago, and in 1878 made 900 thousand; during 1879, they expected to make three millions, employing 40 men.

At Carver the clay used occurs 50 to 90 feet above the river, as a stratum from 30 to 40 feet thick, overlain and underlain by sand, being included in the modified drift which formerly filled this part of the valley. It probably was deposited during the retreat of the ice-sheet which overspread this region, as shown by the interglacial clay at Chaska, after the valley had been excavated between its bluffs of till. J. M. Nye & Co. here make 300 to 500 thousand bricks yearly; and Andrew Ahlin, about two-thirds of a mile southwest from Carver, has two yards, his annual product being from one to one and a half millions.

At Jordan Charles Rodell has made bricks 12 years, averaging about 500 thousand yearly, and selling at $6 per M. This clay deposit, as at Carver, is part of the stratified valley drift. It is 40 feet thick, lying upon till, and overlain by gravel and sand. The top of the clay is about 65 feet above the river. A very interesting kind of stratification is shown by this clay, which is bedded in distinct horizontal layers from 3 to 8 inches thick, averaging 6 inches. These layers are dark bluish, often finely laminated, changing above and below to a nearly black, more unctuous and finer clay, which forms the partings between them. These divisions are clearly seen through the whole extent of Mr. Rodell's excavation, which reaches 25 feet below the top of the clay and is 4 rods long. The same stratification is shown also by the excavation of Nye & Co. at Carver, where the exposure is 4 rods long and 15 feet high, except that here the layers all have a nearly uniform thickness of 3 inches. In this depth of 15 feet there are thus about sixty layers, all exactly alike. The alternating conditions which produced them were evidently repeated sixty times in uninterrupted succession. The only explanation for this which seems possible is that these divisions mark so many years occupied by the deposition of this clay. It appears that these clay-beds are of limited extent. The broad flood-plain was mainly built up by additions of fine gravel and sand spread over its surface by floods like those which now occasionally overflow the bottom-lands. Clay could settle only where hollows were formed by inequalities in this deposition and left outside the path of the principal current. Now nearly all the features of the modified drift, as the general absence of shells or other fossils, its hillocks and ridges called kames, and its occurrence only in glaciated regions or in valleys of drainage from them, indicate that this formation was accumulated by streams discharged from a melting ice-sheet. If the origin of the modified drift that filled the lower part of the Minnesota Valley was from such glacial melting, it is apparent that the floods would be greater and would bring and deposit more sediment in summer than in winter. Layers nearly like those in the clay at Carver and Jordan are also seen in other clay-beds in this valley and in that of the Mississippi in this State. The principal mass of each layer is regarded as the deposition during the warm portion of a year, and the very dark partings as the sediment during winter when the melting was less and the water consequently less turbid. The upper part of these beds of clay are generally colored yellow to a depth varying from one or two to ten feet, the lower portion being blue. The limit of the yellow color in the clay at Jordan runs obliquely, being nearly parallel with the sloping surface, so that the same horizontal layers are partly blue and partly yellow, which shows that this is a discoloration by weathering.

At Belle Plaine, Jacob Kranz has made bricks 10 years; annual product,

300 thousand, selling at $5 to $6 per M. The clay used is recent alluvium of the river, with which he mixes one-sixth as much sand as clay.

At Henderson bricks are made by Herman Matthei, who began 9 years ago, and now averages 400 thousand yearly; and by John Meier, who began in 1878, and expected to make 300 thousand during last season. Both use recent alluvium.

At LeSueur Henry Kruze has made bricks 16 years, using alluvial clay; annual product, 300 thousand. He mixes one part of sand with two of clay. J. Wetter also has made bricks here 8 years, averaging 100 thousand per year. His clay has a thickness of 5 feet, and is underlain by sand, the two forming a terrace about 100 feet above the river.

In Oshawa, about one mile south-west from St. Peter, Matthias Davidson has made bricks 19 years, using the recent alluvium. He averages 400 thousand yearly, and sells at $4 to $7 per M.

The brick-making at Mankato and New Ulm cannot be here reported. At Redwood Falls two kilns of brick, about 200 thousand, were burned by Bohn & Lamberton in 1878. The clay is about 40 feet above the top of the succession of falls here in Redwood river, and about 180 feet above Minnesota river. The section is black soil, 2 feet; yellow clay, dipping slightly eastward, about 7 feet; changing below to yellowish sand. This clay is in layers, mostly about 8 inches thick, divided by dark partings similar to those described at Carver and Jordan. The underlying sand is in layers from ¼ to 1 inch thick, separated by hard films of iron-rust. Attempts to make bricks at Minnesota Falls and Granite Falls have failed, because of small limy concretions in the clay, causing them to crack in burning. Bricks in this region command $8 per M.

At Montevideo, Nils Swennungson has made bricks two years; annual product, 60 thousand, selling at $6 to $10 per M. This clay is on the general level of the upland, 100 feet above the river. The section is soil, 1½ feet; yellow clay, used for brick-making, 3 feet; clayey sand, 6 inches; with clay containing limy concretions below.

At Big Stone City in Dakota, opposite Ortonville, Tobias Oehler began brick-making this year (1879). The clay is nearly like that of Montevideo. During this season he made 240 thousand, selling at $12 per M.

Brief notes of this production in counties north of the Minnesota river are the following, arranged in their order from south-east to north-west: ½ mile west of Dayton, in Otsego, Wright county, by Medor Arseno, about 250 M. yearly, at $7 to $8 per M.; at Cokato, Wright county, by James Runions, 300 M. yearly, for six years, at $8, the clay now nearly exhausted; 2 miles north of Hutchinson, McLeod county, by W. H. Wyman, 100 M. yearly, at $7 to $8; 3 miles north-east from Litchfield, Meeker county, by Henry Ames, 500 M. yearly at $7; at the north-west side of Nest lake in New London, Kandiyohi county, by Peter Larson, Jr., 200 to 300 M. yearly, at $8 to $10; at DeGraff, Swift county, 300 M. were made in 1877, selling at $10 per M.; at Glenwood, Pope county, by John Aiton, 150 to 300 M. yearly, at $7 to $10; 1½ miles north-east of Alexandria, Douglas county, by John A. McKay, 500 M. yearly, at $6 to $10; 3 miles south-west of Alexandria, in sec. 2, Lake Mary township, by Mark Bundy, 75 M. yearly; ½ mile north-west of Evansville station, Douglas county, by Richard Partridge, about 40 M. yearly at $10; about 3 miles west of Parker's Prairie, Otter Tail county,

by Henry Asseln, 100 M. in 1878, at $7 to $10; at Fergus Falls, by J. A. Nelson & Brothers, 100 M. formerly, 600 M. this year (1879), at about $8; 3 miles west of Fergus Falls, by S. R. Childs, 150 M. this year; at Detroit, Becker county, by Shaw & Martin, about 200 M. yearly at $8; and at Moorhead, by Lamb Brothers, 2500 M. yearly, at $6, and by Kruegel & Truitt, 1200 M. yearly. Additional details respecting this work and these and other deposits of clay adapted for brick-making, will be given in the final report.

Lime. The abundance or frequent occurrence of boulders and pebbles of magnesian limestone in the drift of this entire district, has been mentioned in describing that formation. The same stone, more finely pulverized, is one of the most important ingredients of our sand and clay also, being a principal cause of the great fertility of the soil throughout all these counties. A large part of the lime used for building, except along or near the lower Minnesota river, has been derived from the drift, its limestone boulders being gathered upon rocky, morainic areas, or about shallow lakes, where the expansion of the ice in winters has slowly pushed these and other rock-fragments outward to the shore. A little ridge of gravel and boulders is thus frequently heaped to a height varying from four to eight feet above the lake. In nearly every county several of the early settlers have availed themselves of this resource, constructing small kilns and burning from 50 to 200 barrels of lime yearly, according to the demand in their vicinity. This lime is usually of excellent quality, contains little sand, and is white, or sometimes cream-colored. We have a large list of these lime-burners, but can mention here only those who do a permanent and considerable business, as follow: at Dayton, Levi Guier, burning about 500 barrels of lime yearly, sold at $1 per barrel; in Greenleaf, Meeker county, Lewis Maher, from 100 to 300 barrels yearly, at $1.50; near Beaver Falls, Renville county, John Edget, R. R. Corey, and several others, each about 100 barrels yearly, at $1.50; at Minnesota Falls, Simon Christianson and W. C. Darby, each 300 barrels yearly, at $1.50; one mile north of Ortonville, Alfred Knowlton, 500 barrels this year at $1.25; farther north-west, beside Big Stone lake, Jacob Hurley, E. T. Hanes, and William H. Bowman, selling yearly from 150 to 300 barrels each, at $1.25; at Donnelly, Stevens county, Joseph Meier, 300 to 400 barrels yearly, at $1.25; in Evansville, Douglas county, Partridge Brothers, 250 barrels yearly, at $1.25; in Leaf Mountain and Clitherall, Otter Tail county, Orris Albertson and others, 200 barrels or more yearly, at $1.25; at Fergus Falls, J. A. Nelson & Brothers, and E. Barbeau, each about 500 barrels yearly, at $1; in south part of Oscar, Otter Tail county, Peter Carlson, about 400 barrels yearly, at $1; in Eglon, Clay county, Nils Larson, from 75 to 250 barrels yearly, at $1; and at Detroit and White Earth Agency, Becker county, Shaw& Martin, 500 barrels yearly, at $1.50.

Limestone in fragments and pulverized is so large an ingredient of the drift that all percolating waters become more or less charged with carbonate of lime in solution. The soft rain-water is thus changed to hard water before it finds its way into wells or issues in springs. The limestone which the water has taken up forms a scale on the inside of tea-kettles and the boilers of engines; and similarly, because of exposure to the open air and evaporation, it is occasionally deposited by springs as an incrustation of moss, leaves, or other objects, or as a porous bed upon the surface of springy

ground. Interesting springs of this kind occur near Carver, Glenwood, and Big Stone City. Their calcareous deposit is commonly called "petrified moss," from the fact that it becomes covered with growing moss, the lower part of which is being slowly encrusted and its form preserved by this accumulation. It is usually a light gray, very porous mass, less than a foot thick, and mixed with earth and foreign matter; but in two places more massive deposits of this origin are found, which appear to have a value for the manufacture of lime. One of these, occurring in the N. E. ¼ of sec 26 and south part of sec. 23, Tunsburg, Chippewa county, has been considerably burned for lime by E. R. Harkness, who states that it yields a nearly pure, white lime, fully as strong as that of boulders. It here forms a nearly level layer 2 to 3 feet thick, extending fully a half mile as shown by frequent exposures upon the side of the bluff of till north-east of the Chippewa river. Only its south-east portion is adapted for lime-burning, the rest being gravelly. It appears to mark a line at which springs issued because of impervious beds above or below it. These springs are now partly intercepted by a tributary ravine 30 rods north-east, in which "petrified moss" is forming along a distance of about an eighth of a mile, at a height of three to six feet above the rill. About twenty-five miles south-east from this, in the N. W. ¼ of section 22, south township of Hawk Creek, Renville county, a nearly compact calcareous deposit, containing impressions of leaves and sticks, is exposed for six to eight feet vertically in two masses four rods apart, on the south side of a ravine about fifty feet deep. It was probably formed by springs when this ravine was first channelled out, shortly after the glacial period.

Cretaceous strata in the vicinity of New Ulm, and the Shakopee limstone in the lower Minnesota valley, yield the most important supplies of lime derived from this district. The only kiln burning Cretaceous limestone north of Minnesota river and therefore within the limit of this district, is John Heymann's, about a half mile north of Redstone. His yearly product is from 1,000 to 1,500 barrels, sold at $1 per barrel. The section is soil, 2 feet; drift gravel, 1½ feet; cavernous, nodular, gray limestone, 2 feet; green clay with layers of red, 2 feet; and limestone as above, 2 feet; said to be underlain by clays and shales. These beds form a terrace about 35 feet above the river. Other kilns burning lime from this formation are situated on the opposite side of the river. This lime is strong and sets quickly, making a white plaster; except that it commonly includes a little clay, it is quite pure, having no magnesia or sand.

The Shakopee limestone gives a very dark lime, which slacks to a brown or cream color. It is magnesian, with a little admixture of sand, and is burned more easily, slacks with less heat, and sets more slowly, than pure lime. It is preferred by masons for brick and stone work, and for plastering except the finishing coat. The following notes were gathered respecting the manufacture of lime from this formation. At Shakopee, J. B. Conter burns 15,000 barrels yearly, selling it at Saint Paul and Minneapolis for 55 cents per barrel of 200 pounds. The section here is limestone, obscurely and irregularly bedded, yielding leather-colored lime, 6 to 8 feet; a lighter-colored calcareous sandstone, divided in beds about 8 inches thick, somewhat used for building stone, 2 feet; limestone nearly as above, in irregular beds from a few inches to one foot thick, yielding a very dark, blackish lime, 12 feet.

The stratification is nearly level; but all the beds are more or less fractured, porous and cavernous, with different colors in the same layer a rod apart. The color throughout is buff of various shades approaching pink, yellow, and brown. The top of the quarry is about 50 feet above the river, and this formation extends below to the water's edge. Mr. Conter also burns about 15,000 barrels of lime yearly at a quarry 5 miles to the south-west in Louisville. This limestone is nearly like that at Shakopee. It is arenaceous, but shows no continuous layer of sandstone. At Ottawa, Charles Schwartz burns about 400 barrels of lime yearly for the demand in his vicinity, selling at 60 cents per barrel. At Caroline, in sec. 17, Kasota, Conrad Smith burns 6,000 barrels yearly, selling at 55 cents per barrel. A third of a mile south-east from the last, George C. Clapp has burned lime 20 years, averaging 2,000 barrels yearly, but has done nothing in this business during the last two years. The last three use only the upper 2 to 5 feet of the limestone terrace at these places. A large amount of lime is also burned from the Shakopee limestone in Mankato, which is not included in this report.

The St. Lawrence limestone in sec. 13, Jessenland, Sibley county, has been used for lime-burning by Herman Matthei, brick-maker at Henderson. Five kilns of small size were burned here last year, but the stone is now teamed to Henderson before burning. The lime brings 60 cents per barrel.

Quarried Stone. The formations which are quarried in the valley of Minnesota river for building stone, foundations, bridge masonry, or similar uses, are the quartzyte at Redstone, and the three members of the Lower Magnesian group. The granite and gneiss of the upper Minnesota valley have not yet been worked to any considerable extent, but will probably furnish valuable quarries for the general market when a demand is created by the more complete settlement and increasing wealth of that region. Cretaceous sandstone, as previously mentioned, has been quarried slightly for culverts and cellar-walls in Courtland, 8 and 11 miles south-east from New Ulm; but the business is now discontinued or very small.

In the quartzyte at Redstone quarries are owned by Francis Baasen, about 30 rods south-east from the railroad-bridge, who formerly quarried $200 worth of stone yearly, but none for three years past; William Winkelmann, a few rods farther east, quarrying only for his own use in building; Frederick Meierding, a little farther east, now selling $100 worth yearly, formerly about $400 yearly; Gottlieb Arndt, one-fifth mile north-east from last, with annual sales from $50 to $300; and Joseph Reinhart, close east of the last, selling little now, formerly $300 worth per year. Only rough stone of small dimension is obtained, bringing from $2 to $3 per cord.

Quarries in the limestone at St. Lawrence are owned by Abraham Bisson and Philip Corbel, both renting to others the privilege to quarry for 50 cents a cord. The stone is sold at $3 or $3.50 per cord, the first of these quarries supplying fifty cords yearly and the second about twenty cords yearly. The sales for stone work from the quarries in Faxon and Jessenland are still smaller. Of this limestone at Hebron, in the south part of Nicollet township, quarries are owned, in order from east to west, by Abel Keene, William J. Phillips, William H. Thurston, and Mrs. J. H. Dunham. Some of these are rented at 50 cents per cord. The stone is sold for $3 per cord, and the extent of sales at each quarry varies from $100 to $300 yearly. Judson, opposite to Hebron, has other small quarries in this formation.

The Jordan sandstone is quarried at Jordan by Frank Nicolin and Philip Kipp. It lies in beds from eight inches to two or three feet thick. Mr. Nicolin's flour-mill at this place, built of this stone, is 60 by 70 feet in area and 75 feet high, in six stories, having its walls 5 feet thick at the base and 20 inches at the top. Besides this structure, which was erected in 1878 and 1879, Mr. Nicolin's quarry has within three years supplied $2000 worth of stone, sold to the Minneapolis & St. Louis railroad for bridge masonry and to other purchasers. Mr. Kipp's quarry, opened this year, has supplied about $200 worth, at $3.75 per cord. Foss, Wells & Co. also quarried this stone to build their mill and elevator.

The limestone at Shakopee is too much seamed and fractured and too irregularly bedded for use as a building stone. In ascending the river, quarries where stone is obtained from this formation for building purposes are found in Louisville, Ottawa, St. Peter, Kasota, and Mankato, the two last places having the largest business. This work at Mankato we cannot report. Opposite to this city, in Belgrade, three quarries on the land of John Q. A. Marsh and brother are rented mostly to Dennis Sullivan and John Duffee, who pay 50 cents per cord, selling at about $2 per cord for rough stone. A little further west, Andrew M. Wiemar owns a quarry opened last year. He supplies dimension stone, rough or hammered. The rock of these quarries is evenly colored and compact, in thick beds, and can supply blocks 5 by 4 by 2 feet, or slabs 8 feet long. Details of the other places are given in the order mentioned.

In Louisville, Mrs. M. A. Spencer owns a quarry which has been worked 15 years, with annual sales from $200 to $950. This stone is in layers from 1 to 3 feet thick, hard and compact, except that small cavities sometimes occur in it. It has been used for much of the bridge masonry of Scott and Carver counties, including the railroad-bridges at Chaska and Carver.

At Ottawa quarries are owned by Levi Case, John R. Clark, Robert Todd, John S. Randall, Robert Winegar, and Kasper Mäder. The annual product is from 50 to 300 cords from each, sold at $1 to $2.50 per cord. The stone here is in layers from a few inches to one foot thick. It is sold mostly for use within 10 or 15 miles to wall cellars and wells, little being sent away on the cars.

At St. Peter the stone is thinly bedded as at Ottawa, except in the Asylum quarry, where it lies in massive beds 1 to 4 feet thick. This quarry has been worked principally for the Asylum buildings. The other quarries are owned or worked by Jacob Bauer, Hugh Brogan, Ubalt Drenttel, John Malgren, and Henry Miller. Their annual product is 50 to 200 cords each, selling at $1.50 to $3 per cord.

Kasota has the best quarries found in this limestone within our limits. It is in beds from 6 inches to 2½ feet thick, pinkish buff in color, uniform in its texture, easily cut into any desired form, and durable under exposure to the weather. The most extensive business here is that of Breen & Young, who lease from Stewart, Breckenridge & Butters. They employ 35 men and 3 teams at quarrying and loading upon the cars, the product in 1879 being worth $15,000 as rough stone; it is dressed after reaching their shops in Saint Paul and Minneapolis, which brings their sales per year to about $30,000. The largest stone ever shipped by them weighed 10 tons, its dimensions in feet being 14 by 8 by 1. Their quarry can supply blocks of

large size and 2 or 2½ feet thick; slabs, as for cemetery borders, 20 feet long; and flag-stones 10 or 12 feet square and eight inches thick. Examples of the stone from this quarry are the residence of H. J. Willing, of the firm of Field, Leiter & Co., in Chicago; the First Baptist Church in Saint Paul; trimmings of the High School Building in Minneapolis; and trimmings of the State Prison in Stillwater. The only other quarry at this place is owned by J. W. Babcock, whose yearly sales are from $5,000 to $10,000. He has used stone to cut up which formed an unbroken sheet 60 feet long. Examples from this quarry are the trimmings of Odd Fellows' Hall in Saint Paul, and of Plymouth Church in Minneapolis.

VI.

REPORT OF PROFESSOR C. W. HALL.

Prof. N. H. Winchell, State Geologist:

SIR:—The party of the Geological and Natural History Survey of the State, detailed by you to visit Lake Superior during the past summer, was ready for operations the latter part of July. The objects of this expedition were to make collections of the fauna of the Northeastern part of the State, to make some additions to the collection from its flora made by Mr. Juni one year ago, and to make some observations on the rocks and minerals occurring along certain portions of the coast.

In addition to the two persons composing the survey party, there were two others, Rev. C. M. Terry of Minneapolis, and Prof. G. Weitbrecht, of the St. Paul High School. The latter gentleman, teacher of natural history in the institution with which he is connected, accompanied us for the purpose of making collections of geological specimens, alcoholic, dried, and various dissections for his classroom work, and for the museum, of which the St. Paul Board of Education is now laying the foundation. Both gentlemen rendered material aid in performing the various duties of our camp life, and for a considerable share of the time they saved the expense of one extra man.

The constant interest manifested in our work in every way, and particularly by the part they were ever seeking to bear, and the heartiness with which they entered into the spirit of our out-door life, rendered their presence a source of pleasure to us.

We reached Duluth on the morning of July 26. There we made some purchases of supplies, hired a sail-boat for a month or more, and made such other arrangements as were necessary for the character of our work down the coast. We there learned that the winds for some days had been strong up the coast, practically preventing all small sail and row boats from going down the shore. This fact made us anxious to avoid, if possible, the probability of a long and toilsome trip. To be transported to our place of destination, which was Grand Marias, in the course of a few hours, thus passing over the intervening distance without a great waste of time in waiting for winds and waves, and to begin our work at once, since the season for collecting was already far advanced, were with us the chief desiderata. It was through the good offices of Dr. V. Smith, U. S. Collector at Duluth, that we were enabled to realize our wishes. A steamer was to start at noon on her regular trip around the north shore of the lake. The master, when assured of the character of the expedition, offered, so far as he consistently could,

to assist us on our way. We took passage for Prince Arthur's Landing, feeling that if the lake should become so rough as to prevent our leaving the steamer before we had reached the shelter of the group of islands off Pigeon Point, we should even then have saved more than half the distance to our point of destination. The steamer reached what was supposed to be the vicinity of Grand Marias at half-past 11 o'clock at night. As the vessel came to and lowered our boat with our camp equipment and ourselves to the water, a heavy swell was running, and every appearance indicated a southwest wind. Fortunately for us the threatened wind did not rise; still we had ample opportunity to become thoroughly tired rowing our heavily loaded boat. We reached the shore just as day was dawning, and found ourselves about one and one-half miles below Grand Marais.

With Monday morning we entered upon our labors. The work of arranging for our stay was slight, as the Messrs. Mayhe v placed at our disposal an unused building, in which was a stove, the property of the survey, left there last fall at the close of the field work of that season. We pitched our tents on the shingle beach, obtained a stock of supplies, and settled down to steady work.

Mr. Roberts, a student of the University, who accompanied me to assist in making the collections, occupied himself almost exclusively with collecting plants and birds. Of the former here at Grand Marais as elsewhere along the coast we found great numbers, but the range in species was rather narrow. Since the season for the majority of plants was past that of flowering, we did not collect so many specimens as we might have done and should have desired to do earlier in the season. One point of considerable interest could not be investigated, namely: how the flora of the lake basin proper is related to that of the interior drained by the numerous streams that come tumbling down over the escarpment of the bordering ridge of hills and emptying into the lake. The greatest distance towards the interior we reached was only eight or ten miles, and this in the valley of a single river, the Devil's Track; consequently nc generalizations could be drawn.

The list collected by Mr. Juni and published in last year's report,* and to which the list and observations submitted herewith are mainly supplementary, gives, with few exceptions, those plants found growing on the lake shore where the temperature averages several degrees lower during the growing months than it does inland, where the wind, cooled by the waters of the lake, does not reach. No great differences would be expected; stil enough would probably be seen to make a distinction clear with reference to the habits at least of a few species. It would perhaps be premature to designate any particular species which is found in the one locality that is debarred by climatic conditions from existing in the other; yet many might be mentioned which, flourishing along the lake shore, present only scattering representatives, if representatives have been found in the interior, so far as this latter territory has been explored by any party of the survey at present being prosecuted. It is confidently expected that these parties will find as they push into the country to the north and west of Superior and explore the shores and marshes of the hundreds of smaller lakes as yet almost or quite unknown to the white man, many species now not known to science. This additional question ought also to be answered by the more complete results

* Seventh Annual Report, 1878, p. 35, et seq.

of our botanical labors: in what particulars does this lake flora distinguish itself from that of the Mississippi valley only so short a distance away?

One in passing along the shore from Duluth to the easternmost point of Northern Minnesota, may be led to suppose that there is a gradual but sure change in the flora of the shore; that this change is noticeable in the species observed as well as in the size to which they attain. A moment's consideration, however, ought to dispel this wrong impression. In the first place the difference in position is not enough to change materially the characters of the vegetable and animal life of this district. The extremity of Pigeon Point lies near 89° 24′ west and 48° 1′ north, according to the International Boundary Survey charts. Duluth lies near 92° 5′ west, and 46° 47′ north, according to the chart ("Lake Superior No. 3") of the survey of the northern and northwestern lakes. These figures locate the former point about eighty-six miles further north and one hundred and twenty-four miles further east than the latter. It requires a much greater distance than this, where distance alone is considered, to produce any marked change either in the size or the character of species. What differences there are between these two localities one hundred and fifty-one miles apart, must be accounted for on other grounds than distance inland or distance from the equator.

Both points mentioned are situated on the same shore of the same body of water; this body of water is so large and deep as to exert an almost oceanic effect on the climate near its shores, such as imparting a certain moisture to the air and diminishing the liability to sudden changes in its temperature; the temperature is through each season quite equable and very low, and the face of the country stretching inland from Duluth and from Pigeon Point is essentially the same, broken and hilly

Again, during the progress of the geological explorations occasional trips inland were made, and some of the highest summits along the immediate vicinity of the lake were reached. Wherever the hills are covered with a fair depth of soil, whether it be owing to a drift deposit or a level plat from which the slowly formed soil material could not be washed by the heavy rains or the melting snows, they are heavily timbered. And it is not alone in the number of trees and shrubs; rock maples, birches, tamaracks, pines, &c., are found of enormous size. Carlton's Peak, whose summit lies nine hundred twenty-seven (927) feet above the lake level seems to be the only exception. This mountain, whose summit is a huge mass of nearly pure feldspar, bore a very stunted vegetation,—the pines, white birches and mountain ash were very small, but still about as large as one could expect even in a much warmer climate with no more soil for a foothold than this bare rock afforded. One hundred feet below the summit trees and shrubs were as large and as vigorous as at the lake shore. Professor Agassiz with his party ascended Mount Cambridge on St. Ignace Island in 1848, and from observations and collections made at that time he concludes, "that even a thousand feet will introduce very slight differences in the vegetation of these regions. For, though Mount Cambridge is about a thousand feet above the level of the lake, its whole slope is covered with the same vegetation which occurs at the very level of the lake."*

* Lake Superior: Its Physical Character, Vegetation, and Animals, etc. Louis Agassiz, p. 184.

This, then, seems to be the key to all the observable differences: as we go northeastwardly, the coast becomes somewhat changed by the action of those forces which have made it geologically what it is,—a series of igneous dikes and overflows, and of various upheavals of the sedimenary strata.

Towards Pigeon Point the soil becomes thinner, until there is no foothold for vegetation, except in the fissures of the rocks and in hollows filled with rock fragments and vegetable mold.

This, then, seems to be the key to all the observable differences: this peculiar rock conformation has acted both directly and indirectly on the vegetation of the region. Wherever the protruding dikes and other abrupt masses of rock have offered no resistance to the denudation of the hillsides by the flooding streams which are always periodical over tracts so liable as is this to violent storms in summer, and heavy beds of snow in winter, erosion and transportation have been constant. Ever since the early Silurian times, when these beds were probably formed, there has been little or no deposit of soil upon them, resulting from the slow chemical changes in the rocks and the physical disintegration accompanying and resulting from them. These chemical and physical changes, so unremittingly going on, furnish food material for the growing vegetation. And when the areas are vast the differences resulting from different lithological conditions are plainly apparent to one who studies the plants; but here in northeastern Minnesota they are insignificant. Yet vigor of growth depends on soil; when this cannot accumulate, trees must be of diminutive size, and the preponderance of vegetation must be shrubby and herbaceous, giving a general appearance of barrenness to the face of the country.*

In last year's report allusion was made by the State Geologist to the agricultural resources of Northeastern Minnesota.† Further observations and inquiries by this expedition tend to confirm the views therein expressed, so far as they relate to the agricultural capabilities of that part of the State lying immediately along the lake shore. The soil on the hillsides sloping towards the lake appears for the most part to be thin, and the even contour of the surface leads to the belief that were the forests cut away the earth would, in a few years, be carried down into the water by heavy showers, and thus leave a long and almost uninterrupted line of barren rocks from Duluth to Pigeon Point. But when the summits of this ridge skirting the lake are reached a beautiful country of gently rising hills, separated by spacious valleys, extends inland as far as the eye can reach. From the summit of Carlton's Peak, one of the highest points in the northern part of the State, a landscape of surpassing beauty lies before the beholder. The valley of the Temperance river, a considerable stream which flows past the base of this mountain and shoots into the lake from a narrow and remarkable gorge,‡ can be traced as it winds among the hills from many miles inland,

*The subject of "The Vegetation of the Northern Shores of Lake Superior" has been so ably and thoroughly discussed by Professor Agassiz in his intensely interesting work, *Lake Superior; its Physical Character, Vegetation and Animals compared with those of other and similar Regions—Boston: Gould, Kendall & Lincoln*, 1850, that no further discussion is necessary here.

†Seventh Annual Report, 1878, p. 25.

‡Owen's Geological Survey of Wisconsin, Iowa & Minnesota. Phila., Lippencott, Grambo & Co., 1852, pp. 378 and 379.

and the range can be seen, which probably lies beyond this long and narrow lake, in which both the Temperance and the Brulé are said to take their rise. From summits above Caribou Point, Terrace Point, and the mouth of the Devil's Track, as well as from the highest peaks in the Grand Portage Indian Reservation, landscapes of almost equal beauty and attractiveness can be seen.

Throughout the whole distance visited wherever openings have been cut and any attempts at crop raising have been made, excellent success has been met with. At Beaver Bay encouraging accounts were given by Mr. Christian Wieland of experiments made at that place in wheat-raising. From one piece of five acres of newly cleared land sown to wheat 28 bushels, 26 bushels and 23 bushels per acre was the yield for the first three years respectively; and the quality of the grain was excellent Other localities where wheat has been more thoroughly tried have given even more flattering results. The first premium at the State Fair in 1878 gave St. Louis county an enviable reputation among those lying in the winter wheat growing belt of the State. The successful exhibit, that of Mr. Jacob Zimmerman, showed a yield in 1878 of 54 bushels of winter wheat per acre, weighing 62 pounds per bushel, and was grown in sec. 28, township 50, range 15.*

The wooded and broken character of the country is often mentioned as highly favorable to the development of a wheat-producing region, as the danger of loss from wind-storms is thereby materially lessened. The proximity of the lake would have a tendency to keep the temperature low during the season when the wheat berry is forming and ripening; so it seems hardly possible that such a discouraging blight as swept over the southern part of the State in 1878 could ever afflict St. Louis and Lake counties. Oats and barley should by no means be omitted if one were to make out a list of those cereals whose successful cultivation here has been placed beyond a doubt.

Two hundred bushels of potatoes per acre is called a small yield. More than this, the potatoes are of the finest quality. It is claimed in Duluth that in the Chicago market the deliciousness of the Lake Superior potatoes is appreciated so highly as to make them preferred above those from any other locality in the West or Northwest.

But it seems after all as if this part of the State is to be a stock-raising rather than a cereal-producing territory. The peculiar character of the soil adapts it especially to grass, and without the least apparent difficulty the wild species give way to the cultivated. From one and a half to two tons per acre is the usual yield with scarcely any care, and there are many unusually fine meadows in the counties just named. The hillsides, when cleared of the timber now covering them, will afford unsurpassed pasturage, while countless springs and rivulets and larger streams will give a never-failing supply of the purest water,—a condition that must never be overlooked in locating a stock or dairy farm. Convenience to market is another advantage which is here possessed. Cheap transportation by way of the lakes to the great centers of the wholesale trade of the country can be relied on for seven or eight months of the year, and the provident farmer will make his sales to fit the season of prevailing high prices. Hay, live stock,

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* From a Pamphlet issued by the St. Paul & Duluth R. R. Co., St. Paul, Minn., p. 32.

beef, butter, and all farm products can be transported to Chicago and New York as well as can wheat and oats and barley.

Along the hillsides sloping towards the lake, as well as along those lying further inland, there are many scattering pines. Occasionally a section is thickly studded with them. Their scattered occurrence renders these trees practically inaccessible, for the dense forests are impassable before much time has been taken to cut out a trail through the underbrush and the terrible windfalls. Only where many logs can be hauled over a single road can this expense be afforded; hence there are but few places along the shore where any attempts have been made to procure lumber, and those notably in the vicinity of Beaver Bay, and by the Wieland Brothers of that place. These gentlemen have constructed a mill which cuts annually a respectable quantity of timber. They employ about them mostly Indian help, thus settling, so far as their own locality is concerned, the much vexed Indian question. Several parties of pine explorers were met during the season who were searching for pine lands up the rivers along the shore. Every available section bearing pine in any quantity was selected. These explorations were made chiefly, it is believed, in the interests of Michigan dealers.* Private advices from Duluth state also that parties from that place are diligently exploring the whole valley of the St. Louis and its tributaries, and every available section that can be found is taken up, so that in a very short time there will be scarcely an acre of pine land on the market in northeastern Minnesota. Sections containing the scattering trees have no value as "pine lands." It is well known that the trees that stand isolated when of a size suitable for lumber are hollow, or so decayed at the heart that no good logs can be cut from them until the branches are nearly reached.

But more attention was paid to the collection of zoological than of botanical specimens. Mr. Roberts collected one hundred and twenty-five skins of birds,† which are now deposited in the University for study and identification of the species, illustration of varietal characters and for class-room demonstration. In addition to these skins a number of specimens were dissected out and prepared for future use. These specimens consisted of visceral parts, sterna, &c. A full list will find place in the catalogue of the general museum. A number of the sterna from the birds above mentioned have been mounted on pedestals by Mr. Herrick, and they will prove to be a very useful adjunct in studying the form characteristics of those birds from which they were taken, and for illustrating comparative anatomy.

The following are the sterna mentioned; the numbers correspond to the original number of the skins in Mr. Robert's collection, and those without numbers have been added to the list from Mr. Herrick's private collection:

27. Carolina Rail............................*Porzana carolina.*
40. Wild Pigeon............................*Ec.opistes migratorius.*
46. Herring Gull............................*Larus argentatus.*
48. Pigeon Hawk............................*Falco columbarius.*
49. Black-billed Cuckoo....................*Coccygus erythrophthalmus.*

* Some of these "explorers" were employed by English capitalists, the pine being intended for exportation at Quebec.—N. H. W.

†A full list of these skins with the collector's notes have been placed in the hands of the State Ornithologist for publication.

74.	Red-winged Blackbird	*Aegeleus phoeniceus.*
78.	Sparrow Hawk	*Falco sparverius* (2 spec's).
80.	Ring-billed Gull	*Larus delawarensis.*
81.	Broad-winged Hawk	*Buteo pennsylvanicus.*
94.	Hairy Woodpecker	*Picus villosus.*
96.	Great Horned Owl	*Bubo virginianus.*
103.	Mallard Duck	*Anas boschas.*
122.	Northern Phalerope	*Lobipes hyperboreus.*
124.	Golden-winged Woodpecker	*Colaptes auratus.*
125.	Spotted Sandpiper	*Tringoides macularius.*
126.	Night Hawk	*Chordeiles popetue.*
127.	Crow	*Corvus americanus.*
	Chimney Swallow	*Chætura pelagica.*
	Red-headed Woodpecker	*Melanerpes erythrocephalus.*
	Night Hawk	*Chordeiles popetue.*
	Kingbird	*Tyrannus carolinensis.*
	Flicker	*Colaptes auratus.*
	American Bittern	*Botaurus lentiginosus.*
	Great Horned Owl	*Bubo virginianus.*
	Marsh Harrier	*Circus cyaneus.*
	Brown Thrush	*Harporhynchus rufus.*
	Spotted Sandpiper	*Tringoides macularius.*

We hope to make constant additions to this nucleus of exceedingly interesting specimens, and in time to have a complete set from the birds of Minnesota. A hearty invitation is hereby extended to all who are collecting in this attractive field of ornithology to aid the General Museum in this direction. There is no place where that branch of anatomy can be studied with more interest and profit which discloses to us the principles of animal machanism and of animal locomotion.

The collections of insects made during the season were considerable, but with few exceptions they have not yet been fully identified and made ready for the museum. The endeavor will be made during the coming season to arrange all that are of value to us in a manner suitable for use and exhibition.

Of the fishes of this region a fair supply was obtained. Many of the rarer species and those less valued as food fishes were not taken, since no special efforts were made to extend the collection to include what might be considered a series of those species living in the waters of the northern part of the State.

Some very fine specimens of the brook-trout, *Salmo fontinalis*, were obtained from the numerous streams of the region visited. The largest one brought home, a magnificent trout caught with a hook by Rev. C. M. Terry from the Devil's Track, and presented to the collection, measured over twenty-one inches in length, and must have weighed nearly five pounds. One larger brook-trout was seen during the trip. One morning an Indian brought one to our camp at Grand Marais which was over twenty-four inches long and weighed five and three-quarters pounds. It was caught in a gill net in the lake just off the rocky entrance to the harbor. As we had no jar in the museum large enough to hold a fish of this size, we regretted the

necessity that compelled us to make our breakfast that morning on brook trout.

And right here it is appropriate to say that if this survey have economic importance to the people of the State, it should be the effort of those engaged in its work to urge the preservation of what nature has given us in the shape of game, fish, forests, and scenery, as well as to point out the places where precious metals may be found, where fuel lies deposited, or where the finest building stones may be quarried.

The brook-trout is an object of wanton destruction in northeastern Minnesota. This beautiful and universally admired species inhabits, in great numbers, the many small rivers flowing into Superior. These streams, in fact, have become one of the most famous fishing grounds on the continent. That they may continue so, they must be protected. Those within the State of Minnesota are visited annually by large numbers of amateur fishermen, who go in parties, and thus make most enjoyable vacation excursions. A boatman and a cook are engaged at Duluth or some other accessible point, who load into a sail-boat a store of provisions and other essentials to comfort and pleasure, and then take the excursionists to the best trout streams around the lake. One stream after another is visited. A camp is pitched beside each where it empties into the lake. Then, for several days, perhaps a week, the river banks are lined with the creeping, stealthy forms of the fishermen, throwing every temptation the ingenuity of man can devise before the eyes of the wary trout. By diligently and patiently continuing at their posts through every hour from daylight until evening, it is surprising if any fish are spared in the stream. So far as the trout are caught and saved for food within the legal fishing season, it is not proposed here to find fault with the fishermen. The trout is one of those species of fish that breed during the autumn and early winter; so during the latter summer and the autumn months vast numbers are ascending the streams preparatory to selecting a suitable spot for a spawning ground. At this season the fish should be protected, that as large a number of eggs as possible may be deposited. But to catch trout at any season of the year solely for the fun of the fishing is an inhuman and wasteful sport that the State should forbid and punish for what it is—an offense against humanity, public morality, and the future well being of the commonwealth. No milder expression for stating the case can well be used, when a party of anglers fish a stream until every trout that can be captured by all the devices of modern skill and experience, has been brought to land, and then, after the day's catch has been counted, carelessly thrown away where its decay will infect the air or poison the water and thus prevent its being inhabited by others. Specific cases of this character can be mentioned where the waters of streams have been so poisoned in this manner that no fish have lived in them for two or three years. It is a very common thing for parties to fish out a stream and select only the very largest specimens for eating and salting, throwing all the rest, probably three-fourths of their whole number, back into the river. Such treatment of the fishing grounds causes much indignation among the people living in the northern part of the State, and who have a lively interest in the preservation of their fish and game. It is true we have game laws, but it is a very difficult thing to have them enforced so that all would hold a proper respect for them.

One other matter is worth bringing again to the attention of the people of this State.

Last year the State Geologist made protest* against the wholesale destruction of timber in the northeastern part of this State and across the boundary in Canada. A lawless set of "explorers," who own nothing and feel no responsibility, have within the past few years, destroyed more timber and burned down to the rock more of what could be made fine grazing land than probably all the gold and silver they will ever find can pay for. This frequent destruction, for it occurs every year of late, has been chiefly wanton, only occasionally are the fires the result of accident. Very often when an "explorer" finds a vein of quartz or calcite with a sprinkling of galenite or blende, crossing one of the river gorges so common in that part of the State, he takes, its direction and coolly proceeds to set fires along its course, that when the leaves and soil are burned off he may examine it in various places across the country, and, if there be a trace of any metal, proceed to mark out mining locations. The land is not his; the agent or the owner is a hundred or more miles away and can know nothing of the crime; while the party committing it has a possible chance of becoming rich from the fractional ownership in the spot which he receives from the speculator who furnishes him with his outfit. The northeastern part of Minnesota, together with the contiguous part of Canada, may develop into one of our finest mining regions,—in fact there are many geological indications of its exceeding richness in minerals, but the writer has no idea that its product from this source will ever approach the capability of this area considered as a well developed agricultural and grazing region.

Mining operations cannot be carried on successfully in this region for many years to come. The country is still a primeval wilderness. There are no inhabitants beyond the borders of the lake. There are no means of communication from one point to another, except by rough narrow trails and by canoes. The mining locations thus far taken possession of will average from thirty-five to forty-five miles from the lake shore. Mining supplies and provisions for the interior must be taken to the place of operations by troops of Indian packers, each one of whom takes a package of about one hundred pounds weight, which he transports in a canoe along the navigable water-courses and carries on his back suspended by a strap across his head whenever he leaves his canoe. In the winter season trains of dogs are brought into requisition, and these poor abused creatures would, if they only could, pray for death every hour of the day as a relief from their surfeit of starvation and the heartless cruelty of their treatment. Such is the usual mode of transportation; but where a settled business is established other and more civilized methods are adopted,—usually on the plan of each male member of the settlement doing a share of the work proportionate to his strength. The Mayhew brothers of Grand Marais each winter as soon as snow falls fit up their train consisting of a dog, a billy goat and a bull.

During the past season a road has been cut through the forest, along the shore of the lake from Duluth to Grand Marais. This road is a very primitive affair: the trees along its course have been cut down to the roots, old logs have been removed, knolls cut away and the streams spanned with

*Annual Report for the year 1878, p. 24.

corduroy bridges; in short, a broad trail has been opened chiefly for the dog trains that carry the Canadian mails during the period when navigation from Prince Arthur's Landing to Duluth is closed by the ice. This government trail will, no doubt, eventually develop into a substantial highway, as soon as there is a demand for its more thorough construction and constant repair. But the lake will always be used as the cheapest and readiest means of transit during those months of the year when navigation is open, and it will more and more be brought into use as the increasing demands of this large contiguous territory make more regular and frequent the trips of the various lines of boats and packets.

Another step looking towards the development of this lake Superior portion of the State, has been taken. It has long been deplored by those familiar with the northwest shore of the lake that there was throughout its whole distance, from Pigeon Point to Duluth, no shelter where the larger boats could find refuge from storms. The whole extent of this coast line is rocky: it has but two or three natural harbors, and is exceedingly liable to storms and heavy winds, especially in the autumn. An appropriation was made by the present Congress, at its first session, of ten thousand dollars, for dredging and otherwise improving Grand Marais harbor. This harbor is one of the most beautiful spots to be seen anywhere around the great lakes. The bay is nearly circular, about two miles in circumference, and entirely inclosed from the lake, excepting a natural entrance, about one thousand feet wide. The inner shore of the bay is composed of the characteristic brown shingle of the north shore, while along its front a wall of solid rock separates the inclosed water from the lake. The natural depth of the water reaches from fifteen to seventeen feet, but the area over which this depth is reached is not large enough to admit the handling of large vessels within the bay. The improvements of Grand Marais harbor have been begun under a United States engineer, Major Allen, of St. Paul, who will make it ready to meet the necessities of the navigation of this part of lake Superior, just as fast as the U. S. government will appropriate money for carrying on the work.

The foregoing remarks have been written in the endeavor to point out the present and immediately prospective condition of the mining and other industries in this part of the State, and to show the absolute lack, so far as the needs of the mining interests are concerned, of the shadow of an excuse for the wholesale destruction of forests which there annually occurs.

The suggestion of the State Geologist, expressed last year, is most heartily seconded that some action be taken, either in concert with the Canadian authorities or by this State alone, towards repressing this destruction. If no other way be sufficient, it would well pay to employ officers to ferret out violations of law and to bring offenders to punishment.

So far as the geological and mineralogical work is concerned there is but little to report at this time. The observations made were limited, for the most part, to a strip of coast lying between the mouth of Poplar River and that of the Devil's Track. This section is about twenty-five miles long. It is, like all the rest of the distance from Duluth to Pigeon Point, rocky and often precipitous. The rock strata, almost entirely dark-colored basic, and of igneous origin, belong evidently to the so-called cupriferous series of the Lake Superior system; the only exceptions so far as noticed were,

according to present recollection, an outcrop of quartzytic conglomerate below Poplar River, a bed of sandstone varying not far from one hundred feet in thickness, sandwiched in between two beds of the igneous rock at Good Harbor Bay, and several outcrops of shale in the neighborhood of Grand Marais. This latter rock, even when not in sight along the shore, discloses its presence under the water or underneath the drift or lacustrine deposits above the beach by the shingle beaches it makes. Its color is a prevailing reddish brown, and it is very generally highly fractured; indeed, in the vicinity of the dikes, which frequently break through it, the beds are literally shivered into fine fragments.

These pieces are easily broken away by the combined action of the frost and waves, and the ceaseless movement of the water wears them to a smooth and uniformly flattened form, induced by the distances between the jointed surfaces. The hardness of the rock is very uniform, consequently the "shingle" is composed of pebbles of constant size and very regular outlines.

So far as can be judged from three or four thin sections, hastily examined, the igneous rock is a diabase. Essentially the same rock is found below Duluth, and the microscopical characters show but little variation throughout the whole coast-line wherever this modification appears—no more than would naturally be expected, perhaps, in extending the observations of a single series over so large an extent of territory as the northern border of this Lake Superior basin comprises.

A section of the rock at Good Harbor bay shows a triclinic feldspar and augite as the two most abundant constituents, together with some granules of ferric oxide and magnetic iron. In the freshest parts the bed shows no extended decomposition. The feldspar seems to have been developed first, since it shows long, slender crystals lying in all directions through the rock. For the most part the crystals are so small that they show only two lamellæ, thus reminding one of Carlsbad twins so clearly shown in some orthoclase or monoclinic crystals of feldspar. There are, however, many larger porphyritic crystals of feldspar which show undoubted triclinic striations, and contain numerous inclusions,—rectangular, spherical, and of every imaginable form and appearance. The augite is granular for the most part, though there are some clearly defined crystal outlines. On the whole, it seems to fill the interstices between the feldspar crystals wherever there is space to occupy, yielding but very little to the other constituent and the various accessory minerals. Toward the top of the beds decomposition has greatly changed the outward appearance, and has produced a corresponding change in the mineral constitution of the rock. Resulting from the decomposition and disintegration of these primary constituents are many secondary products of various chemical constitution and physical characters. The two most commonly occurring secondary minerals in diabasic rocks are ferric oxide and chlorite, or some green mineral of substantially the same general properties. In this particular locality the minerals resulting from this decomposition are unique and interesting. The most interesting one, perhaps, to the mineralogist, is the Thomsonite,* with Lintonite as a modification; but it is a modification possessing such marked characters that, in the opinion of Professor C. N. Shepard, as expressed in a private letter to Pro-

* See the American Journal of Science and Arts for February, 1880, article Lintonite and other forms of Thomsonite, by S. F. Peckham and C. W. Hall.

fessor Peckham, it will hold its place as a distinct species. These minerals do not occur in every part of these diabasic beds, but only in those parts that seem to be the upper and porous layers of the overflow. Their habitus is quite unmistakably amygdaloidal, and in size they reach as high as three inches in diameter.

In addition to the observations, here only outlined, which were made along the shore, trips were also made to the summits of several of the series of elevations composing the Sawteeth Mountains, a range extending from Carlton's Peak down the coast to the Devil's Track and beyond.

These elevations are formed by the combined result of igneous action, foldings of the sedimentary strata and erosion. The beds have a general southerly dip. As they rise from the lake at an angle varying from eight to twelve degrees, they reach a height of 600 or 800 feet and even more at a short distance from the shore, since the latter's course is southwest and northeast. On reaching the above mentioned height the summits break off in perpendicular precipices, one hundred or two hundred feet in height, banked up at the bottom with huge taluses of broken fragments of the fallen rock. Invariably at the foot of such a precipice there runs a stream generally of considerable size, which discloses in the outcrops along its bed the general character of the lower layers of the rock. The rock which forms these summits seems to be substantially the same as the shore line diabase, &c.; and, indeed, in some places the continuous bedding can be traced, with but little interruption, from the summit almost to the shore; this is the case at Black Point, where a stream called Indian Camp river, courses along under the talus of Black Point Mountain, and finds its way down to the lake over a continuously rocky bed until it reaches almost the water's level. The rock at the top of this peak is highly porphyritic, and also carries many thomsonites. In the bed of the stream just named, near one hundred and fifty feet below the summit, the rock is very compact and carries but few thomsonites and occasional feldspar crystals. These latter attain a length of two inches or more and are filled with inclusions that impart a peculiar greenish tinge to their color.

It has already been stated that the rock constituting the summit of Carlton's Peak is a nearly pure feldspar. This rock is very coarsely granular, —the grains often showing a cleavage surface of half an inch or more across. Without being more definite it can be stated the feldspar is a variety of the triclinic group. The summits of other peaks consist of a porphyry of which, in many hand specimens at least, seventy per cent. of the mass is composed of large crystals of triclinic feldspar; while the rock along the shore is fine in texture and presents only occasional crystals of this mineral.

So the question very naturally arises in the mind of the observer,—Are not these three types mere steps in the modification of one and the same rock species? And he will at once set to work to trace out the probabilities and the possibilities in the case. Indeed, so long as the continuity of the bedding cannot easily be followed from the fresh massive rock at Good Harbor bay to the typical feldspar of Carlton's Peak, many facts seem to favor the acceptance of the theory that a sufficient change has been effected through the slow action of those chemical and physical forces ever accom-

plishing metamorphism to bring about all the differences to be seen in the specimens collected consecutively between these two extreme points.

Yet there are some objections to swallowing this theory wholly without mastication. The first one is suggested by the lithological structure of Carlton's Peak itself;* another may occur to one while observing the huge blocks of feldspar imbedded in what Dr. Norwood calls basalt,† at several places along the shore below the mouth of Split Rock river; still another objection is suspected to lie in the composition and nature of the feldspar itself. Only a careful study in the field and in the laboratory will settle the question.

The list of plants herewith reported comprises all those which were found and of which specimens were secured. There are upwards of one hundred additional to those reported by Mr. Juni, last year. Some of them seem to be the same as are contained in that collection, but under another name. It was thought best, therefore, to include all in this list and leave all corrections to the expert who shall hereafter, from the plants on hand, make a corrected list for final publication.

PLANTS OF THE NORTH SHORE OF LAKE SUPERIOR, MINNESOTA.

COLLECTED BY THOS. S. ROBERTS.

The area embraced by the following list is a narrow strip of country along the north shore of Lake Superior from Duluth to the mouth of the Devil's Track River, forming the greater part of the lake front of St. Louis and Lake counties, Minn. The period of observation was from July 26 until Sept 2, 1879.

The botany of the same region was reported upon by Mr. B. Juni, in the report for 1878; but as considerable new matter was obtained the past summer it has been thought best to present the full list of the species identified the present season with brief notes on their occurrence.

In the introduction to the report on Ornithology will be found a short description of the general character of the country worked over, so that it is not necessary to repeat it here. The vicinity of Duluth was examined very little, or no doubt many other introduced and marsh plants would have been found. As the party landed only here and there along the shore, and with the exception of two or three places but for a brief stay, it is not possible to give the general distribution of but a few species, and those the most noticeable ones. In other cases the locality where the species was found and its abundance there is all that can be given with any degree of certainty.

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* Owens' Geological Survey of Wisconsin, Iowa and Minnesota, Norwood's Report, p. 380.

† The same, p. 360, et seq.

The species marked with an asterisk (*) are in addition to Mr. Juni's list.

RANUNCULACEÆ. Crowfoot Family.

1. Clematis Virginiana, *L.* Common Virgin's Bower.—Occasional. Summit of Black Point Mountain and at Beaver Bay. In fruit Aug. 24.

2. Thalictrum Cornuti, *L.* Tall Meadow-Rue.—Common.

*3. Ranunculus abortivus, *L.* Small-flowered C.—Black Point. Fruit Aug. 24.

4. Ranunculus Pennsylvanicus, *L.* Bristly C.—Common everywhere.

5. Caltha palustris, *L.* Marsh Marigold.—Common.

*6. Coptis trifolia, *Salisb.* Three-leaved Goldthread.—Abundant, especially along Devil's Track River. In fruit Aug. 15.

7. Aquilegia Canadensis, *L,* Wild Columbine.—Grand Marais.

8. Actaea spicata, *L.*, var. rubra, *Michx.* Red Baneberry.—Common.

*9. Actaea alba. *Bigel.* White Baneberry.—Common. This and the preceding fruiting in August.

NYMPHAEACEÆ. Water-Lily Family.

10. Nuphar advena, *Ait.* Common Yellow Pond-lily.—Common in suitable places as in the pond at Grand Marais.

*11. Nuphar luteum, *Smith,* var pumilum. Small Yellow Pond-lily.—Found quite common and in bloom in Duluth Harbor July, 1877.

FUMARIACEÆ. Fumitory Family.

13. Corydalis glauca, *Pursh.* Pale Corydalis—Common and in full bloom, Aug. 25, on the nearly bald summit of Carlton Peak.—Grand Marais.

14. Corydalis aurea, *Willd.* Golden Corydalis.—Duluth, July, 1877.

CRUCIFERÆ. Mustard Family.

*15. Capsella Bursa-pastoris, *Moench.* Shepherd's Purse.—Abundant.

VIOLACEÆ. Violet Family.

*16. Viola rotundifolia, *Michx.* Round-leaved Violet. A violet, apparently this species, bearing so late in the season only cleistogamic flowers and fruit was common in the forest.

DROSERACEÆ. Sundew Family.

17. Drosera rotundifolia, *L.* Round-leaved Sundew.—Common in the marsh at Grand Marais and in a like situation on Minnesota Point.

HYPERICACEÆ. St. John's-wort Family.

*18. Hypericum mutilum, *L.* St. John's-wort.—Common near Stuart river, where it closely approaches var, *Gymnanthum.* Beaver Bay.

*19. Elodes Virginica, *Nutt.* Marsh St. John's-wort. Common; in fruit latter part of Aug. in marshes at Duluth and near Stewart river.

CARYOPHYLLACEÆ. Pink Family.

*20. Cerastium viscosum, *L.* Larger Mouse-ear Chickweed.—Beaver Bay and Duluth; common. Is apparently this species and not *nutans*, *Raf.*

*21. Lychnis Githago, *Lam.* Corn Cockle.—Duluth.

GERAUIACEÆ. Geranium Family.

22. Geranium Carolinianum, *L.* Carolina Cranesbill.—Little Marais.

23. Impatiens fulva, *Nutt.* Spotted Touch-me-not.—Common everywhere. At Beaver Bay a spotless variety, with less reflected spur, was common and grew intermingled with the ordinary form, without showing any signs of intergradation.

*24. Oxalis Acetosélla, *L.* Common Wood-sorrel.—Common in the deep Arbor-vitæ swamps. In this species each petal has a yellow spot at the base inside.

*25. Oxalis stricta, *L.* Yellow wood-sorrel.—Common at Beaver Bay. Duluth.

ANACARDIACEÆ. Cashew Family.

26. Rhus Toxicodendron, *L.* Poison Ivy.—Minnesota Point; common.

SAPINDACEÆ. Soapberry Family.

27. Acer spicatum, *Lam.* Mountain Maple.—Abundant all through the woods, and in fruit in August.

28. Acer saccharinum, *Wang.* Sugar Maple.—"Sugar bushes" are common, and a large amount of maple sugar is made by the Indians.

LEGUMINOSÆ. Pulse Family.

*29. Trifolium pretense, *L.* Red Clover.—About towns. Common at Beaver Bay and Duluth; scarce at Grand Marais.

*30. Trifolium repens, *L.* White Clover.—Common.

31. Lathyrus maritimus, *Bigelow.* Beach Pea.—In addition to the three localities given by Mr. Juni this pea also occurs commonly at Beaver Bay and Sandy Beach; and doubtless at numerous other points along the shore. In the two localities just mentioned it was in bloom sparingly in the latter part of August, while a few plants were in fruit at Poplar River Aug. 6. It does not seem to be very faithful.

ROSACEÆ. Rose Family.

32. Prunus Pennsylvanica, *L.* Wild Red Cherry.—Fruit ripe in latter part of August.

33. Spiræa opulifolia, *L.* Nine-Bark.—Common on the rocks all along the shore, where it was covered with bloom and fruit in the latter part of July and August.

34. Spiræa salicifolia, *L.* Meadow Sweet.—Common on the "peninsula" at Grand Marais.

*35. Geum macrophyllum, *Willd.* Avens.—Abundant.

36. Geum strictum, Ait. Avens. Grand Marais; in fruit July 31.

37. Potentilla Norvegica, *L.* Cinque-foil.—Common.

38. Potentilla fruticosa, *L.* Shrubby Cinque-foil. Abundant. Growing everywhere on the damp, moss-covered rocks, where not washed by the waves, and in full bloom during the early part of August.

39. Potentilla tridentata, *Ait.* Three-toothed Cinque-foil. Everywhere common on the rocks and on Minnesota Point. In the last locality it grows in the dry, loose sand.

*40. Potentilla palustris, *Scop.* Marsh Cinque-foil.—Grand Marais; common.

41. Fragaria vesca, *L.* Wild Strawberry.—Devil's Track River.

42. Rubus Nutkanus, *Mocino.* White-Flowering Raspberry.—Abundant everywhere, but especially along old trails and about clearings. Ripening fruit first week in August.

43. Rubus triflorus, *Richardson.* Dwarf Raspberry.—Common.

44. Rubus strigosus, *Michx.* Common Wild Raspberry.—Abundant and wonderfully prolific. The fruit this year principally during the latter part of August.

45. Rosa lucida, Ehrhart. Dwarf Wild-Rose. Common on sandy soil.

46. Pyrus Americana, DC. American Mountain Ash.—A common tree, attaining considerable size. Professor Winchell collected specimens where the trunk was at least 12 inches in diameter, and perfectly sound. Others, though unsound, were 15 and 16 inches.

47. Amelanchier Canadensis var. oblongifolia. June Berry.—A small tree found at Devil's Track River Aug. 21, with few mostly unripe berries could be referred only here. It seemed very late in the season for the fruit of this species to be still unripe.

SAXIFRAGACEÆ. Saxifrage Family.

*48. Ribes rotundifolium, *Michx.* Gooseberry.—Grand Marais. In fruit second week in August.

49. Ribes lacustre, *Poir.*—Gooseberry. Grand Marais. In fruit Aug. 12.

50. Ribes prostratum, *L'Her.* Fetid Currant. "Skunk-Berry."—Everywhere common.

51. Ribes rubrum, *L.* Red Currant.—Found sparingly at Black Point, with ripe fruit Aug. 24.

*52. Mitella nuda, *L.* Bishop's Cap.—Common at Grand Marais, and doubtless elsewhere.

ONAGRACEÆ. Evening Primrose Family.

53. Circæa alpina, *L.* Enchanter's Night-shade.—Abundant everywhere.

54. Epilobium angustifolium, *L.* Great Willow-herb.—Common, especially on burnt areas.

55. Epilobium palustre, *L.*, var. lineàre, Willow-herb.—Common in a marsh near Stewart River.

56. Epilobium coloratum, *Muhl.* Willow herb.—Common.

57. Œnothera biennis, *L.* Evening Primrose.—Common.

UMBELLIFERÆ. Parsley Family.

58. Heracleum lanatum, *Michx.* Cow-Parsnip.—Common.

59. Cicuta bulbifera, *L.* Water-Hemlock.—Common about a marshy pond near Stewart River.

*60. Sium lineàre, *Michx.* Water Parsnip.—Common on low-ground near Stewart River.

61. Sium Carsoni, *Durand, ined.* Water Parsnip.—Specimen doubtfully referred to this species.

ARALIACEÆ. Ginseng Family.

62. Aralia hispida, *Michx.* Bristly Sarsaparilla.—Common along the shore.

63. Aralia nudicaulis, *L.* Wild Sarsaparilla.—Woods; common. Fruiting middle of August.

CORNACEÆ. Dogwood Family.

64. Cornus Canadensis, *L.* Dwarf Cornel.—Abundant everywhere. In fruit and flower first week of August. Some blossoms appear to turn pink with age.

65. Cornus circinata, *L'Her.* Round-leaved Cornel.—Carlton's Peak, Aug. 25. In fruit.

66. Cornus stolonifera, *Michx.* Red-osier Dogwood. Kinnikinnik.—Abundant.

CAPRIFOLIACEÆ. Honeysuckle Family.

67. Linnæa borealis, *Gronor.* Twin-flower.—This pretty little plant, the Dwarf Cornel and the Clintonia are the most common small flowering plants found in the moss-carpeted forest. Out of blossom for the most part before our arrival.

68. Lonicera hirsuta, *Eaton.* Hairy Honeysuckle.—Mouth of Devil's Track River; green fruit Aug. 21.

69. Diervilla trifida, *Mœnch.* Bush Honeysuckle.—Abundant.

70. Sambucus pubens, *Michx.* Red-berried Elder.—Common. In fruit in the early part of August.

71. Viburnum Opulus, *L.* High-bush Cranberry.—Ripe fruit, Aug. 25.

RUBIACEÆ. Madder Family.

72. Galium asprellum, *Michx.* Rough Bedstraw.—Common. In bloom Aug. 21.

*73. Galium trifidum, *L.* Small Bedstraw.—Grand Marais; Beaver Bay; common.

74. Galium triflorum, *L.* Sweet-scented Bedstraw.—Common. In bloom and fruit at Grand Marais, Aug. 20.

COMPOSITÆ. Composite Family.

75. Eupatorium purpureum, *L.* Je-Pye Weed.—Abundant at Devil's Track Lake.

*76. Aster macrophyllum, *L.* Aster.—Abundant at Grand Marais and elsewhere; coming into bloom the first week of August.

77. Aster sagittifolius, *Willd.*—Very common, and in full bloom during latter part of August.

*78. Aster miser, *L.*, *Ait.*—Common.

*79. Aster simplex, *Willd.*—This or a closely allied species grew in abundance on a piece of low ground near Stewart River, forming dense, rank clumps, in full bloom Aug. 31.

80. Aster puniceusus, *L.*—Quite frequent.

81. Aster ptarmicoides, *Torr. & Gr.*—Very common all along the shore, growing in the clefts of the rocks. In full bloom the latter part of July.

*82. Erigeron Canadensis, *L.* Horse-weed.—Grand Marais.

*83. Diplopappus umbellatus, *Torr. & Gr.* Double-bristled Aster.—Abundant; just coming in bloom Aug. 11.

84. Solidago bicolor var. concolor. Golden-Rod.—Common everywhere on rocks.

*85. Solidago latifolia, *L.*—Beaver Bay; common.

*86. Solidago stricta, *Ait.*—Grand Marais; common on wet ground.

*87. Solidago arguta, *Ait.*—Common.

*88. Solidago memoralis, *Ait.*—Minnesota Point; rather common.

*89. Solidago gigantea, *Ait.*—Beaver Bay and Duluth; common.

90. Heliopsis lævis, *Pers.* Ox-eye. Grand Marais and elsewhere.

*91. Helianthus giganteus, *L.* Wild Sun-flower.—Frequent along Beaver Bay Creek.

*92. Bidens frondosa, *L.* Common Beggar-ticks.—Duluth; common.

*93. Bidens cernua, *L.* Small Bur-Marigold.—Common in a marsh near Stewart River.

*94. Maruta Cotula, *DC.* May-weed.—Duluth.

95. Achillea Millefolium, *L.* Common Yarrow.—Abundant. The rose colored variety occurs sparingly, showing all shades of color from white to a quite deep pink.

*96. Artemesia biennis, *Willd.* Biennial Wormwood.—Duluth.

*97. Antennaria margaritacea, *R. Brown.* Pearly Everlasting.—Beaver Bay; common.

*98. Cirsium undulatum, *Spreng.* Thistle.—In a grass field at Grand Marais. Said to have made its appearance the year previous,

99. Hieracium Canadense, *Michx.* Canada Hawkweed.—Abundant; blooming first week in August.

*100. Hieracium scabra, *Michx.* Rough Hawkweed.—Beaver Bay; frequent.

101. Nabalus albus, *Hook.* White Lettuce.—Grand Marais.

*102. Taraxacum Dens-leonis, *Desf.* Common Dandelion. Beaver Bay and Duluth.

*103. Mulgedium leucophæum, *DC.* False or Blue Lettuce.—Occasional.

*104. Sonchus asper, *Vill.* Sow-Thistle.—Grand Marais, Beaver Bay.

LOBELIACEÆ. Lobelia Family.

105. Loblia Kalmii, *L.* Kalm's Lobelia.—Growing quite commonly in little tufts in the clefts of the rocks along the shore.

CAMPANULACEÆ. Campanula Family.

106. Campanula rotundifolia, *L.* Harebell.—Common; varying through intermediate forms to the variety *linifolia*.

107. Campanula aparinoides, *Pursh.* Marsh Bellflower.—Grand Marais; quite common. In bloom Aug. 12.

ERICACEÆ. Heath Family.

108. Vaccinium Oxycoccus, *L.* Small Cranberry.—Common in the marsh at Grand Marais and on a small island in Superior Bay.

*109. Viccinium Pennsylvanicum, *Lam.* Dwarf Blueberry.—Grand Marais.

110. Chiogenes hispidula, *Torr. & Gr.* Creeping Snowberry.—Grand Marais. In fruit near Devil's Track Lake the middle of August.

111. Arctostaphylos Uva ursi, *Spreng.* Bearberry.—Grand Marais; common. Fruit ripe in August.

112. Gaultheria procumbens, *L.* Aromatic Wintergreen.—Minnesota Point; common. In blossom Sept. 1.

*113. Cassandra caliculata, *Don.* Cassandra.—Minnesota Point; common on low ground. Grand Marais.

*114. Andromeda polifolia, *L.* Andromeda.—Common in the marsh at Grand Marais.

115. Ledum latifolium, *Ait.* Labrador Tea.—Abundant. Far advanced in fruit at Grand Marais, July 28.

116. Pyrola rotundifolia, *L.* Round-leaved Winter-Green.—Black Point.

117. Pyrola chlorantha, *Swatz.* Winter-green.—Common. Fruit Aug. 24.

118. Pyrola secunda, L. Winter-green.—Common.

119. Moneses uniflora—. One-flowered Pyrola.—Grand Marais. In blossom July, 31.

*120. Chimaphila umbellata *Nutt.* Princes Pine. Pipsisewa.—Local. Common at Devils' Track Lake and just passing out of bloom, Aug. 16. Minnesota Point; sparingly in bloom, Sept. 1.

121. Monotropa uniflora, *L.* Indian Pipe.—Common. In bloom and fruit latter part of August.

*122. Monotropa Hypopitys, *L.* Pine-sap.—Only two specimens found Caribou Point, Aug. 24 in full bloom; summit of Carlton Peak, Aug. 25, in fruit.

PLANTAGINACEÆ. Plantain Family.

123. Plantago major, L. Common Plantain.—Rove Lake Trail, etc.

PRIMULACEÆ. Primrose Family.

124. Primula Mistassinica, *Michx.* Primrose.—A very abundant plant, forming thick patches along the crevices of the rocks all along the shore. Out of blossom and fruitage on our arrival, July 27.

125. Trientalis Americana, *Pursh.* Star-flower.—Common everywhere; mostly out of blossom before Aug. 1.

126. Lysimachia stricta, *Ait.* Loosestrife.—Grand Marais; common. Came into bloom early in August.

LENTIBULACEÆ. Bladderwort Family.

*127. Utricularia vulgaris, *L.* Greater Bladderwort.—Common in a pond near Stewart River. In bloom Aug. 30.

*128. Pinguicula vulgaris, *L.* Butterwort.—Rather common about pools and wet mossy places on the rocks. Wholly out of blossom on our arrival, July 27.

SCROPHULARIACEÆ. Figwort Family.

*129. Verbascum Thapsus, *L.* Common Mullein.—Common in an old pasture at Beaver Bay.

130. Chelone glabra, *L.* Turtle-head.—Black Point; common.

131. Mimulus ringens, *L.* Monkey Flower.—Common on low ground near Stewart River. Out of bloom Aug. 30.

*132. Veronica Americana, *Schweinitz.* American Brookline.—Beaver Bay.

*133. Euphrasia officinalis, *L.* Eyebright.—Abundant everywhere about the edges of mossy thickets, especially on the rocky "peninsula" at Grand Marais. In bloom the last of July and during August. Small and little-branched in exposed situations; larger and much branched among other vegetation.

134. Melampyrum Americanum, *Michx.* Cow-Wheat.—Minnesota Point; common. In bloom and fruit Sept. 1.

LABIATÆ. Mint Family.

*135. Mentha Canadensis, *L.* Wild Mint.—Grand Marais; common.

136. Lycopus Virginicus, *L.* Bugle-weed.—Common.

*137. Nepeta Cataria, *L.* Catnip.—Grand Marais; about an old garden.

138. Brunella vulgaris, *L.* Self-heal.—Beaver Bay; common.

*139. Scutellaria galericulata, *L.* Scullcap.—Cascade River. Grand Marais.

*140. Scutellaria lateriflora, *L.* Mad-dog Skullcap.—Rove Lake Trail.

141. Galeopsis Tetrahit, *L.* Common Hemp-Nettle.—Very common; growing on the shingle especially. Corolla almost universally white, marked with yellow in the throat; rarely purple.

*142. Stachys palustris var. asper. Hedge-Nettle.—Little Marais. Palisades, Aug. 26; common and in bloom. The variety *cordata* common near Stewart River.

BORRAGINACEÆ. Borage Family.

143. Mertensia paniculata, *Don.* Smooth Lungwort.—Abundant. The flower buds pink, turning blue as they open, thus giving the flowering plant a showy, varigated appearance. Still blooming in August.

GENTIANACEÆ. Gentian Family.

144. Halenia deflexa, *Grisebach.* Spurred Gentian.—Common.

145. Menyanthes trifoliata, *L.* Buckbean.—Grand Marais. D. T. Lake. Out of bloom.

CHENOPODIACEÆ. Goosefoot Family.

*146. Chenopodium album, *L.* Lamb's Quarters.—Grand Marais; on cultivated ground.

*147. Blitum capitatum, *L.* Strawberry Blite.—Minnesota Point. Ripe fruit and blossoms, Sept. 2.

*148. Corispermum hyssopifolium, *L.* Bug-seed.—Common on Minnesota Point. [It may be of interest to note that this plant also occurs in the vicinity of Minneapolis, though not heretofore reported from the State.]

AMARANTACEÆ. Amaranth Family.

*149. Amarantus retroflexus, *L.* Pigweed.—Duluth; common.

*150. Montelia tamariscinia,—.Common on Minnesota Point and about Duluth.

POLYGONACEÆ. Buckwheat Family.

*151. Polygonum viviparum, *L.* Albine Bistort.—A single plant in bloom, and with many red bulblets, found at Grand Marais, Aug. 21.

*152. Polygonum Persicaria, *L.* Lady's Thumb.—Common.

*153. Polygonum Hydropiper, *L.* Common Smart-weed.—Duluth; common.

*154. Polygonum acre, *H. B. K.* Water Smartweed.—Common.

*155. Polygonum amphibium var. terrestre, *Willd.* Water Persicaria.—Common near Stewart River, and one form close to rarity *aquaticum*.

*156. Polygonum articulatum, *L.* Joints red. Common and in full bloom Sept. 1, on Minnesota Point. A very pretty plant, growing in the dry sand.

*157. Polygonum aviculare, *L* Knotgrass.—Common.

*158. Polygonum sagittatum, *L.* Arrow-leaved Tear-thumb.—Common around a pond near Stewart River.

*159. Polygonum Convolvulus, *L.* Black Bindweed.—Common about cultivated grounds.

160. Polygonum cilinode, *Michx.* Black Bindweed.—Abundant; springing up in profusion on burnt areas.

*161. Rumex orbiculatus, *Gray.* Great Water Dock.—Near Stewart river; common.

162. Rumex Acetosella, *L.* Sheep Sorrel.—Common all along the shore.

CALLITHRICHACEÆ. Water Starwort Family.

*163. Callitriche verna, *L.* Water Starwort.—Common: Pallisades, Duluth, etc. Growing both in and out of water. Fruit and flowers, Sept. 2.

URTICACEÆ. Nettle Family.

164. Urtica gracilis Ait. Common Nettle.—Common.

CUPULIFERÆ. Oak Family.

165. Corylus rostrata, *Ait.* Beaked Hazel-nut.—Common; in fruit Aug. 5.

BETULACEÆ. Birch Family.

166. Betula papyracea, *Ait.* Paper Birch.—Abundant everywhere. The bark of this tree, together with that of the "Cedar" (Arbor-vitæ), is made use of in innumerable ways by the Indians.

167. Alnus viridis, D. C. Green Alder.—Common. Forming small clumps along shore, wherever it can get a foot-hold.

SALICACEÆ. Willow Family.

168. Populus tremuloides, *Michx.* American Aspen.—Abundant.

CONIFERÆ. Pine Family.

169. Pinus Banksiana, *Lambert.* Northern Scrub Pine.—Common.

170. Pinus Strobus, L. White Pine.—Common; but there is no extensive pine forest on the immediate shore.

171. Abies niger. *Pair.* Black Spruce.

172. Abies alba, *Michx.* White Spruce.

173. Abies balsamea, *Marshall.* Balsam Fir.

174. Larix Americana, *Michx.* Tamarack.—Common, growing often on high ground.

175. Thuja occidentalis, *L.* American Arbor-vitæ. Forming the dense, almost impenetrable "cedar-swamps" of this region. Attains a large size —two to three feet in diameter.

176. Juniperus communis, *L.* Common Juniper. Minnesota Point; common.

177. Taxus baccata, *L.*, var. Canadensis. Am. Yew. Ground Hemlock. —Abundant. Fruit ripe during August.

ARACEÆ. Arum Family.

178. Cala palustris, *L.* Water Arum.—Stewart river. Common about Duluth; blooming in July.

179. Acorus Calamus, *L.* Sweet Flag.—Duluth; common.

LEMNACEÆ. Duckweed Family.

*180. Lemna minor, *L.* Duckweed.—Duluth harbor; common.

TYPHACEÆ. Cat-tail Family.

*181. Typha latifolia, *L.* Common Cat-tail.—Duluth; common.

NAIADACCEÆ. Pond-weed Family.

*?182. Potamogeton Claytoni, *Tuckerman.* Pond-weed.—Common in a small stream near Stewart River.

*183. Potamogeton amplifolius, *Michx.*—Devil's Track Lake; common.

*184. Potamogeton gramineus, *L.*—Devil's Track Lake; abundant. Fruiting middle of August.

ALISMACEÆ. Water-Plantain Family.

*185. Triglochin maritimum, *L.* var. elatum. Arrow-Grass.—Duluth; common.

*186. Alisma Plantago, L., var. Americanum. Water-Plantain.—Duluth; abundant. Blossom and fruit Sept. 2.

*187. Sagittaria variabilis, *Engelm.* Arrow-head.—Common near Stewart River.

HYDROCHARIDACEÆ. Frog's-bit Family.

*188. Anacharis Canadensis, *Planchon.* Water-weed.—Duluth harbor; common.

*189. Vallisneria spiralis, *L.* Eel-grass. Water Celery.—Duluth harbor; common.

ORCHIDACEÆ. Orchis Family.

*190. Habenaria viridis, *R Br.*, var. bracteata, Reichenbach. Rein-Orchis.—Carlton's Peak, Aug. 25; in bloom.

191. Habenaria obtusata, *Richardson.* Rein-Orchis.—Abundant; blooming July and August.

192. Habenaria orbiculata, *Torr.* Orchis.—Devil's Track River.

*193. Goodyera repens, *R. Br.* Rattlesnake-Plantain.—Abundant.

*194. Calopogon pulchellus, *R. Br.* Grass Pink.—Common on a small island in Superior Bay. Blooming middle of July [1877.]

*195. Calypso borealis, *Salisb.* Calypso.—Some dead scapes and flowers collected at Black Point, Aug. 24, are evidently referable to this species.

IRIDACEÆ. Iris Family.

196. Iris versicolor, L. Large Blue Flag.—Grand Marais; common.

LILIACEÆ. Lily Family.

*197. Trillium cernuum, *L.* Wake-Robin.—Grand Marais. In fruit Aug. 15.

*198. Streptopus roseus, *Michx.* Twisted-Stalk.—Common. Fruiting during August.

199. Clintonia borealis, *Raf.* Northern Clintonia.—Abundant and in fruit.

*200. Smilacina bifolia, *Ker.* False Solomon's Seal.—Common.

201. Smilacina trifolia, *Desf.* False Solomon's Seal.

202. Lilium Philadelphicum, *L.* Wild Orange-red Lily.—Occasional along the shore.

FELICES. Ferns.

203. Polypodium vulgare, *L.* Polypody.—Abundant; growing on the rocks.

204. Pteris aquilina, *L.* Common Bracke.—Common about Devil's Track Lake and along Rove Lake Trail.

*205. Asplenium Filix-fœmina, Bernh. Spleenwort.—Common.

*206. Phegopteris polypodioides, *Fée.* Beech-Fern. Abundant.

*207. Phegopteris Dryopteris, *Fée.* Beech Fern.—Common everywhere.

*208. Aspidium spinulosum, *Swartz.* var. dilatatum. Wood-Fern.—Cascade River.

*209. Cystopteris bulbifera, *Bernh.* Bladder-Fern.—Cascade River.

*210. Cystopteris fragilis, *Bernh.* var. dentatum, *Hook.* Bladder-Fern.—Cascade River.

211. Onoclea sensibilis, *L.* Sensitive-Fern.—Abundant along the Devil's Track River.

*212. Woodsia Ilvensis, *R. Brown.* Woodsia.—Very common on the rocks all along the shore. A dwarf form, one to three inches high, yet fruiting freely, was common in the clefts of the rocks on the summit of Carlton Peak.

*213. Osmunda regalis, *L.* Flowering-Fern.—Common along Devil's Track River.

*214. Osmunda Claytoniana, *L.* Flowering-Fern.—Rove Lake Trail.

*215. Osmunda cinnamomea, *L.* Cinnamon-Fern.—Common.

LYCOPODIACEÆ. Club-Moss Family.

*216. Lycopodium lucidulum, *Michx.*—Carlton's Peak; abundant. Mouth of Devil's Track River.

217. Lycopodium annotinum, *L.* Common everywhere.

218. Lycopodium dendroideum, *Michx.* Ground Pine.—Common.

219. Lycopodium clavatum, *L.* Common Club Moss.—Common.

220. Lycopodium complanatum, *L.*—Devil's Track Lake; rather common.

VII.

CHEMISTRY.

REPORT OF PROF. PECKHAM.

Prof. N. H. Winchell:

MY DEAR SIR: Permit me to submit the following report of Chemical work done for the Geological Survey since my last report.

The three specimens of iron ore, numbered 58, 61 and 62,* were examined in accordance with the instructions conveyed by your letter of June 10th, 1879, as follows:

In the analysis of the iron ores, determine the following:

Insol. siliceous matter.
Sulphur (or Sulphuric Acid.)
Phosphorus (or Acid.)
Lime.
Magnesia.
Manganèse Oxide.
Alumnina.
Iron as metal.
Iron as protoxide.

(Signed) N. H. WINCHELL.

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* In the Seventh Annual Report were given the Analysis of:

No. 55. A Siliceous Magnesian Limestone, from Tom's Quarry, Sugar Loaf, Winona.
No. 56. Limestone from Shakopee, (Museum number 2165).
No. 57. Limestone from Clapp's Quarry, (Shakopee formation), near Mankato.

Other numbers are from the following localities:

No. 58. Siliceous Iron Ore, four miles west of Cannon Falls, (Mus. No. 418).
No. 59. Close-grained Limstone, Le Roy, (Mus. number 2238).
No. 60. Red Quartzyte, from the Pipestone quarry.
No. 61. Iron Ore, from the Mesabi Range, (Survey No. 438, of field-book No. 38.)
No. 62. Iron Ore, from the Mesabi Range, (Survey No. 441, of field-book 38).
No. 63. St. Lawrence Limestone, Winona, (Museum No. 219).
No. 64. Shakopee Limestone, from Kasota. The Kasota building stone.
No. 65. St. Lawrence Limestone, from St. Lawrence, with green sand, (Mus. No. 2169).
No. 66. Combustible Shale, Lower Trenton, Prairie Creek quarries, Rice Co., (Mus. No. 2564).
No. 67. Cretaceous Clay (or Shale), Mankato, (Mus. No. 2159).

[N. H. W.]

The results obtained are given below.

IRON ORES.

Number.	58.	61.	62.
Insoluble siliceous matter	47.75	14.98	16.29
Sulphur or Sulph. Acid, SO_3	.120	.32	.27
Phosphorus (or Acid), $P_2 O_5$	.002	none.	trace.
Lime, Ca O	trace.	trace.	trace.
Magnesia, Mg O	trace.	trace.	trace.
Manganese Oxide, Mu O	trace.	2.13	.094
Alumina, $Al_2 O_3$	.700	3.35	.92
Ferric Oxide, $Fe_2 O_3$	51.017	76.7297	45.554
Iron, Fe	35.7137	53.7134	59.999
Ferrous Oxide, Fe O	none.	none.	36.143
Magnetic Oxide, $Fe_3 O_4$	none.	none.	82.858

Numbers 61 and 62 are pure and valuable iron ores.

Number 63 is a limestone, containing druzy cavities filled with white quartz. It consists of:

	Per cent.
Insoluble matter	6.58
Soluble Silica, $Si O_2$, Aluminic Oxide $Al_2 O_3$ and Ferric Oxide, $Fe_2 O_3$	14.26
Calcium Carbonate, $Ca CO_3$	39.338
Magnesium Carbonate, $Mg CO_3$	34.734
Sulphuric Oxide, SO_3	trace.
Undetermined Alkaline Carbonates	5.088
	100.000

Number 64 is a remarkably pure Magnesian limestone. It consists of:

Insoluble matter, (chiefly Silica) $Si O_2$	13.85
Soluble Silica, SiO_2, Alumnic Oxide Al_2, O_3, and Ferric Oxide $Fe_2 O_3$	1.49
Calsium Carbonate, $Ca C O_3$	47.904
Magnesium Carbonate, $Mg C O_3$	35.227
Sulphuric Oxide SO_3	trace.
Water and Alkalies, undetermined	1.529
	100.000

Number 65 appeared to the eye to be identical with number 31—the St. Lawrence limestone—containing Glauconite, already reported,* to you in my report dated Jan. 9th, 1877.

The portion of the rock that is soluble in cold hydrochloric acid contained:

Calcium Carbonate, $Ca CO_3$
Magnesium Carbonate, $Mg CO_3$

*See Report State Geologist, Minnesota, 1876, pg. 61.

Calcium Silicate, $Ca_2 Si O_2$
Ferrie Oxide, $Fe_2 O_3$
Manganic Oxide, Mn O.

Angular grains of silica and small green grains remained undissolved. The green grains varried in size from one thirty-second (estimated) of an inch in diameter to those of inappreciable dimensions. Most of the grains of silica were about the size of mustard seed, but many of them were extremely small, rendering the complete separation of the grains of silica and the green grains impossible. It was also found impossible to make any two estimates of the composition of the soluble portion that would correspond. The insoluble silica and green grains both together and separately are not uniformly distributed through the rock, so that only an aproximation can be made of the mixture of which the rock is composed. Of the piece examined 6.771 per cent. was insoluble. I think the piece selected was a fair average. The analysis of the green gains will be found to correspond very closely with that before reported.*

	Per cent.
Silicic Oxide, $Si O_2$	48.131
Ferrous Oxide, Fe O	27.063
Aluminic Oxide, $Al_2 O_3$	6.962
Manganic Oxide, Mn O	trace.
Calcium Oxide, Ca O	trace.
Potassium Oxide) $K_2 O$	6.982
Sodium Oxide, $Na_2 O$	1.931
Water, $H_2 O$	8.841
	99.910

These results, like those previously reported, indicate a glauconite insoluble in hydrochloric acid.†

Number 66 is a shale or clay containing organic matter and calcium carbonate. Sixty-one per cent. is insoluble in hydrochloric acid. This insoluble material consists of:

Organic, combustible matter	22.87
Silicic Oxide $Si O_2$	25.20
Aluminic Oxide, $Al_2 O_3$ plus a trace of Ferric Oxide, $Fe_2 O_3$	8.96
Barium Sulphate, $Ba SO_4$	3.0057
Magnesium Oxide, MgO	.973
Calcium Oxide, CaO	trace.
The soluble material consisted of:	
Ferric Oxide, $Fe_2 O_3$ plus Aluminic Oxide, $Al_2 O_3$ plus a trace of Ferrous Oxide, FeO	2.20
Calcium Carbonate, $Ca CO_3$	20.809
Calcium Sulphate, $Ca SO_4$	.2035
Magnesium Carbonate, $Mg CO_3$	12.986
Water and trace of alkalies	2.7928
	100.0000

It is quite possible that this shale, if mixed with clay in proper proportion

*Ibid.

†Dana's Min. Geology, Ed. 1870, page 462.

and burned, would furnish hydraulic cement. The burning would require very little extra fuel.

Number 67 is a highly siliceous clay. Its composition places it with orthoclase, although it has the physical properties of kaolin. It is chemically a slightly decomposed feldspar, while it has the appearance and some of the properties of clay. It, however, appears to contain too much iron to admit of its being used for white ware, although a practical test is often required to definitely settle the value of clays for such purposes. It was found, on analysis, to contain:

	Per cent.
Water, H_2O	1.980
Silicic Oxide, SiO_2	70.100
Aluminum Oxide, Al_2O_3 plus Ferric Oxide, Fe_2O_3 a trace	16.990
Sulphuric Oxide, SO_3	00.231
Potassium Oxide, K_2O	10.695
	99.996

Very respectfully yours,

S. F. PECKHAM,
Chemist to the Geol. Survey.

THE UNIVERSITY OF MINNESOTA,
Jan. 28, 1880.

VIII.

ORNITHOLOGY.

REPORT OF DR. P. L. HATCH.

Prof. N. H. Winchell—

DEAR SIR: The increased facilities for extending my observations over new sections of the State, which your considerations afforded me, have enabled me to achieve more satisfactory results than in the preceding year.

I not only visited remote points of great interest, but have thus succeeded in enlisting competent assistants who have entered into the exploration of their special localities with great enthusiasm. Several such have given me carefully prepared reports of what they have accomplished, which I reserve to draw upon in making up my final report. I have held several such over the last year from Messrs. T. S. Roberts, C. L. Herrick, R. L. Williams and E. L. Hood, which, but for a little misapprehension, I should have handed you a year ago.

I am gratified, however, to know that they do not regret the omission. I am under renewed obligations to these young and enthusiastic naturalists for their hearty co-operation. They will pardon my constitutional caution in not publishing observations in natural history prematurely: they are better, sometimes, like wine, for having been kept a time. It is often the case that but *half* of the truth is a *whole* falsehood. I am anxious to gather data from more than half of the field before attempting to extract reliable truth for the whole. However, I have a paper from your assistant, Prof. C. W. Hall, prepared by Mr. T. S. Roberts, his assistant, in a Geological and Natural History exploration of the north-west shore of Lake Superior, that is so complete in itself and covers a hitherto unexplored region of such interest to ornithologists, that I cannot withhold it for my completed report without injustice, not only to those gentlemen, but to all who are interested in the fauna of that interesting region. You will find it inclosed herewith. With renewed assurances of my interest in the work I have undertaken and my sincere acknowledgments for your official and personal kindness uniformly manifested to me, I remain,

Yours very truly,

P. L. HATCH.

No. 818 Nicollet Av., Minneapolis, March 5, 1880.

Dr. P. L. Hatch, State Ornithologist—

SIR: I transmit to you herewith a list of birds collected by Mr. Thomas S. Roberts. During the past summer a geological and collecting corps of the Geological and Natural History Survey of this State was sent by the State Geologist to the northwest shore of Lake Superior for studying certain geological and mineralogical characters along the cost, and for making collections of the fauna and flora of that region, that the same might be represented in the General Museum of the University.

Mr. Roberts was my assistant on that expedition, and I am pleased to have an opportunity here to bear record to his untiring industry and patience, to his quickness and exactness in observation, and to the thoroughness with which he followed out the details of every examination.

The skins of the birds collected and the sterna and parts of the viscera of many of them are in the Museum of the Univerity, where yourself and all others interested in Ornithology can have free access to them for study and comparison.

Very truly yours,

C. W. HALL.

THE UNIVERSITY OF MINNESOTA, Feb. 25, 1880.

A PARTIAL LIST

OF THE

BIRDS OF ST. LOUIS AND LAKE COUNTIES, MINN.

These two counties, St. Louis and Lake, form the triangle which projects eastward from the northern half of the State of Minnesota, between Lake Superior and the British possessions. Each is of large dimensions, and together they form an extensive tract of country, representing the wild, heavily timbered area of the State. This list of birds, however, relates only to a narrow strip along the lake shore, between the mouths of the St Louis and Devil's Track Rivers—a general coast line of about one hundred and twelve miles. From Grand Marais, one hundred and eight miles below Duluth, a collecting trip was made six or eight miles inland to a sheet of water known as Devil's Track Lake. This proved to be a quite large and pretty lake, with low, rocky shores and timber growing to the very water's edge. From its eastern end flows the river of the same name, a considerable stream, which, after receiving several affluents and making a descent of over a thousand feet, enters Lake Superior about four miles below Grand Marais.

This whole extent of country is covered with a dense forest, consisting for the most part of evergreens, white birch and poplar, which everywhere encroaches close upon the water's edge, whether it be along the banks of the rivers or the shore of the lake. Indeed, it is alone the action of the

water that establishes the line beyond which the trees cannot advance, and owing to the abrupt, rocky character of the entire shore this line is close to the water and very sharply defined. It is but a step from the gloomy forest to the bare rock or shingle beach, and usually but a half dozen more down over the water-worn rock to the icy waters of the lake itself. The rivers, entering the lake, between rocky walls, and with scarcely an opening among the trees, vary but little the general uniformity of the forest line. About the only breaks in this monotony are "burns," small areas from which the timber has been cut, and now and then a hard-earned clearing which has most likely been abandoned to grow up in saplings and brush. Aside from the low ground about the mouth of the St. Louis River, only two small marshes, scarcely worthy of mention, were seen. One of these constitutes the *marais* from which Grand Marais takes its name, and the other, of somewhat greater dimensions, lies just above Stewart River. Neither is directly connected with the lake.

Every field ornithologist is aware that birds, as a rule, do not like the deep, sombre forest, but frequent by preference the edges of woods or open spots where they can get air and sun-light as well as suitable food. This is well illustrated on the "North Shore;" for the vicinity of towns, abandoned clearings, and old burnt sections were found to be by far the best collecting grounds. A long walk through the forest, resulted generally in hearing only a few Red-eyed Vireos singing high up among the trees, encountering perhaps a noisy, roving troop of Chickadees or a few warblers, stragglers from the outside, flitting about among the tree-tops.

Near Duluth are marshes and a number of cultivated fields, and we find that such birds as the Yellow-winged and Savanna Sparrows, Grass Finch, Bobolink, etc., are to be found. But other than in these two localities there is little or no cultivated ground within the region examined. At Grand Marais, which was our headquarters, there are two or three large partial clearings and a low ⊣ shaped peninsula, which bears only bushes and stunted trees, conditions which make this a fair locality for the bird-collector.

Considerable disappointment was felt at not finding several species of birds that were confidently looked for, and which, in all probability, do occur. Among these may be named the Mourning Warbler, Canada Jay, White-winged Crossbill, Banded Three-toed Woodpecker, Pileated Woodpecker and two or three species of owls. The Canada Jay and Pileated woodpecker were known to residents, and the former said to be common and noticeable in the fall and winter. Owls appeared to be scarce. We ourselves noted but few, though camping along the shore for over five weeks, and little could be learned of them from resident hunters.

The work of the present season (1879) was included between the dates July 26th and September 2d. In July, 1877, the writer spent a few days collecting at Duluth, and as the notes taken at that time have never been published, they are incorporated in this list in order to render it as full as possible. All matter introduced from this source is inclosed in brackets, as the work was done independent of the survey.

One hundred and twenty-five (125) skins representing fifty-five (55) species, were taken the present season. Seven (7) additional species are represented in the University Museum, and the writer's collection by speci-

mens previously taken on the north shore, which makes sixty-two (62) species that rest on the capture of specimens. The remainder were seen and well identified by the writer with the exception of a single species,—the White-headed Eagle, which is included upon hearsay.

The name of a locality accompanied by only a date signifies that the species was taken at that time and place. These records of capture have been introduced quite frequently as giving a degree of definiteness to the observations.

1. [Turdus migratorius, *Linn.* Robin.—Common at Duluth in July, 1877.]

2. [Turdus swainsoni, *Cab.* Olive-backed Thrush.—A specimen (var. *swainsoni*) was taken at Duluth, July 16, 1877.]

3. [Sialia sialis, (*Linn.*) *Hald.* Blue-bird.—Several pairs seen at Duluth in July, '77.]

4. Parus atricapillus, *Linn*, Black-capped Chicadee.—Common. Found often in the deep woods where few other birds live.

5. Sitta canadensis, *Linn.* Red-bellied Nuthatch.—Not very common. Its trumpet like notes betraying its presence much oftener than a sight of the bird itself. Poplar River, Aug. 6.

6. Certhia familiaris, *Linn.* Brown Creeper.—Noted quite frequently. Seen at Grand Marais July 28 and on Minnesota Point, Sept. 1.

7. Troglodytes aedon parkmani, Western House Wren.—Taken at Grand Marais, where several were seen. I am at a loss to account for the apparent scarcity of this species along the shore as I found it in July, 1877, very common among the burnt and fallen timber about the Northern Pacific Junction and Duluth. A number of specimens taken at that time show a very light coloration; and in fact all the wrens of this species that I have taken in Minnesota are noticeably light colored. In view of this fact I recently sent a small series of skins from different localities in the State to Mr. Robt. Ridgway for identification. His reply was that the specimens were all *parkmani*, and extremely typical of that form. Again in a subsequent letter he says "Your wrens surprised me very much, as I was prepared to find them *aëdon*. They are the *most* typical specimens of *parkmani* I ever saw."

Mr. T. M. Trippe in his paper* upon the birds of central Minnesota gives Bewick's Wren as common and breeding, and includes the House Wren only with doubt. Yet in this same general region I have found only the House Wren abundant during the breeding season and have never seen Bewick's Wren.

8. [Mniotilta varia, (*Linn.*) *Vieill.:* Black and White Creeper:—Seen on Minnesota Point, July 11, 1877.]

9. Helminthophaga ruficapilla, (*Wils*) *Bd.* Nashville Warbler.—Common in latter part of August. Devil's Track Lake, Aug. 18. Beaver Bay, Aug. 28, etc.

10. Helminthophaga peregrina, (*Wils*) *Cab.* Tennessee Warbler.—Very common; forming often the greater part of the rambling companies of migrants found in open places and on the edges of the timber after the second week in August. In full song at Devil's Track Lake on Aug. 16. Grand Marais, Aug. 13. Beaver Bay, Aug. 27, etc.

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*Proc. Ess. Inst. VI. 1871, p. 115.

11. [Dendrœca æstiva, (*Gm*) *Bd.* Yellow Warbler.—Several noted at Duluth in July, 1877.]

12. Dendrœca virens, (*Gm*) *Bd.* Black-throated Green Warbler.—Grand Marais; two specimens taken July 28 and Aug. 13. [Duluth, July 16, '77.]

13. Dendrœca cœrulescens, (*Linn*) *Bd.* Black-throated Blue Warbler.—Two males taken at Poplar River, Aug. 6. From the anxiety displayed by one of these it seemed that the young were still under the care of the parents. The second male was in full song.

14. Dendrœca coronata, (*Linn*) *Gray.* Yellow-rumped Warbler.—Common at Devil's Track Lake, Aug. 16–18. Three specimens (young) taken the 16th.

15. Dendrœca blackburniæ, (*Gm.*) *Bd.* Blackburnian Warbler. A female accompanied by her brood of young was found on Aug. 10 among the dense underbrush of an old clearing at Grand Marais. They kept close to the ground, chirping constantly, and were very difficult to start from their place of concealment. Two of these were secured. Devil's Track Lake, Aug. 18.

16. Dendrœca striata, (*Forst.*) *Bd.* Black-poll Warbler.—Beaver Bay, Aug. 27, '79 (a young bird).

17. Dendœca castanea, (Wils.) Bd. Bay-breasted Warbler.—Devil's Track Lake, Aug. 16. Seen also at Black Point Aug. 24.

18. Dendrœca maculosa (*Gm.*) *Bd.* Black and Yellow Warbler.—Common. Found in small companies during the first part of August, the broods having not yet broken up. Moulting at this time. Devil's Track Lake, Aug. 16. Beaver Bay, Aug. 27.

19. Dendrœca palmarum, (*Gm.*) *Bd.* Yellow-red-poll Warbler.—Apparently not common. Beaver Bay, Aug. 27.

20. Dendrœca tigrina, (*Gm.*) Bd. Cape May Warbler.—Taken at Grand Marais, Aug. 13, and believed to have been seen at Devil's Track Lake, Aug. 16.

21. [Siurus auricapillus, (*Linn.*) *Sw.* Golden-crowned Thrush.—Several noted at Duluth in July, '77.]

22. Siurus nævius, (*Bodd.*) *Coues.* Small-billed Water Thrush.—Common at Devil's Track Lake. A thick growth of evergreens and birches, growing close to the water's edge and projecting out low over the water for a number of feet, formed a most congenial haunt for this bird. Though so late in the season (Aug. 15–18) they were uttering their ringing, emphatic song with seemingly all the vigor of spring. They sang chiefly in the morning, from daylight until eight or nine o'clock, and then again for a short time in the evening. As stated by several authors, the song bears a striking resemblance to that of the Mourning Warbler (*Geothlypis philadelphia*). Seen on the lake shore only at Black Point, Aug. 24.

23. Geothlypis trichas, (*Linn.*) *Cab.* Maryland Yellow-throat.—Seen only once, near Stewart river, Aug. 30. [Common at Duluth, in July, '77.]

24. Geothlypis philadelphia, (*Wils.*) *Bd.* Mourning Warbler.—Common about Duluth in July, 1877. The following extract from a paper contributed by the writer to the Linnean Society of New York City, in February, 1879, may be of interest in this connection. In the vicinity of Minneapolis it [*G. philadelphia*] has been met with very rarely and only during the migrations. Its capture, several years ago, by Dr. P. L. Hatch and Mr. W. L. Tiffany; the taking of two males on May 18, 1877, by Mr. R. S. Williams,

and a male of the year on Sept. 2, 1876, by the writer, about comprises its history in this locality. Dr. Hatch's words, "rare and unnoted," convey a correct idea of its occurrence here.

"Leaving Minneapolis we will pass due north about one hundred and twenty-five miles, into Carlton and St. Louis counties. Here is one vast extent of forest, largely of pines and other evergreens, but with hardwood ridges and tamarack swamps interspersed. In many sections extensive fires have raged on the low grounds during dry seasons, completely killing the timber, especially in white-birch regions. The fallen, charred timber, piled promiscuously among the dense tangled undergrowth that springs up, forms as pathless and impenetrable a place as one can well imagine, and the dead and blasted trees which remain standing on all sides, give to the country a most desolate appearance. Among several features rendering these barren wastes attractive to the ornithologist, is their being the summer home of the Mourning Warbler. During the second and third weeks of July, 1877, we found this warbler about the Northern Pacific Junction (Carlton Co.) and Duluth (St. Louis Co.) in such numbers as to fully warrant its being called common. It was at that time in song and breeding. The males were conspicuous from their habit of sitting on the dead trees to sing; but the females were seldom seen, as they kept down in the thick cover. The males would sit for a long time on the limb of a dead tree, motionless, but for the occasional utterance of their brief song. In quality their singing is much like that of the Maryland Yellow-throat; but the song, as I heard it, consists of five notes, the first three just alike, followed by two others, louder and fuller. The whole is loud, clear and ringing and forms an interesting song, but I suspect its attractiveness is due, in great measure, to the fact that it is the utterance of the Mourning Warbler. When the singer is disturbed he either flies to another tree, near by, to continue his performance or dives into the thickets below, where he is safe until he may see fit to reappear.

"The nest we did not find, though we greatly excited several pairs by our close approach to it. When thus disturbed, both male and female would utter forcible sparrow-like chirps, move actively from bush to bush, frequently passing nervously over every limb and twitching their bodies much in the manner of the Yellow-throat (*G. trichas*) under similar circumstances. A few, at least, had young upon our arrival (July 6), and we several times saw them (male as well as female) carrying large green caterpillars, such as one could scarcely imagine a young Mourning Warbler swallowing. On July 18th, at the N. P. Junction I came upon a brood of young out of the nest, but not able to fly above a few yards. They were in a dense place and kept close to the ground, only appearing for an instant now and then, when beaten from some bush. They chirped loudly, very much like the old birds. As late as July 18, at the date of our departure, the males were still in song.

"T. M. Trippe found this warbler abundant and breeding through the central part of this State in the summer of 1870, and to him is due the credit of ascertaining that the timber wilds of Minnesota are so eminently its home.

"It is a strange fact that the Morning Warbler should be so rare about Minneapolis during the migrations and yet so common all the season little more than a hundred miles farther to the north. It would seem that they must certainly pass by here; yet in what manner is something of a mystery.

The unsuitable character of the country is the evident explanation of their absence during the summer."]

Contrary to expectation nothing was seen of the species the present season, but the vicinity of Duluth was examined scarcely at all. Though why certain burned areas about Grand Marais and elsewhere were not inhabited by this bird is not quite evident.

25. Myiodioctes pusillus, (*Wils.*) Bp. Wilson's Blackcap.—Noticed several times in the latter part of August. In song. Beaver Bay, Aug. 27.

26. Myiodioctes canadensis, (*Linn.*) *Aud.* Canadian Flycatcher—Common; frequenting the undergrowth. During the early part of August its actions indicated that it was still looking after its young. In song at Devil's Track Lake, Aug. 15-18. Taken at Poplar River, Aug. 4; Grand Marais, Aug. 13.

27. Setophaga ruticilla, (*Linn.*) Sw. Redstart.—Common. A pair seen at Poplar River, Aug. 6, feeding young not more than two or three days from the nest. Grand Marais, Aug. 9.

28. [Pyranga rubra, (*Linn.*) *Vieill.* Scarlet Tanager.—A male, seen at Duluth, July 16, '77.]

29. [Tachycineta bicolor, (*Vieill.*) *Cab.* White-bellied Swallow.—Common at Duluth in July, '77.]

30. Hirundo horreorum, *Barton.* Barn Swallow.—A single male flew around the boat between Poplar and Cascade rivers on Aug. 4 and [several were seen at Duluth in July, '77.]

31. Petrochelidon lunifrons, (*Say*) *Scl.* Cliff Swallow.—One seen between Beaver Bay and Duluth.

32. Progne purpurea, (*Linn.*) *Boie.* Purple Martin.—Common. Mr. Thos. Mayhew, of Grand Marais, told us that they occupied his Martin box last season; but none were present this year. The last week of August many large loose flocks were seen flying south-westward and keeping over the water a short distance from shore.

33. Ampelis cedrorum, (*Vieill.*) *Cab.* Cedar Bird.—One of the commonest birds of this region. They occurred both in small flocks and in pairs, and some evidently had nests in the latter part of August. No young of the year were seen. At Devil's Track Lake in particular they were observed to display their ability as fly-catchers to an extent not before noticed by the writer. Regularly each morning and evening they were perched on the tops of the tallest trees about the lake shore, making sallies in all directions after passing insects and returning again to their station, almost like so many pewees or King Birds.

34. Vireo olivaceus (*Linn.*) *Vieill.* Red-eyed Vireo.—Common, and one of the few birds found regularly in the deep forest, where its song was often the only sound to break the stillness. Beaver Bay, Aug. 28.

35. [Vireo solitarius, (*Wils.*) *Vieill.* Solitary Vireo.—A single individual seen at Duluth, July 16, '77.]

36. [Carpodacus purpureus, (*Gm.*) *Gray.* Purple Finch.—A young bird taken at Duluth, July 16, '77, and others seen.]

37. Loxia curvirostra, americana, (*Wils.*) *Coues.* Red Crossbill.—Common all along the shore, but noticed more particularly at Poplar River and Grand Marais. They were in pairs or small parties of six or eight individuals, and gave evidence of a restless, roving disposition. Alighting, they would feed

industriously about the tops of the evergreens for a short time, when all of a sudden, at the sound of a few sharp notes, uttered by one of the party, they were off over the forest with wayward, erratic flight, sounding their call note as they went. They are not at all shy, but on the contrary are tame and unsuspecting birds. The roof of a house, the immediate door-yard, a tree standing close beside a dwelling are as likely resorts as other equally suitable localities. A tall, isolated pine, standing but a few feet from our shanty at Grand Marais, was a favorite stopping place for birds of this kind, and on several occasions they descended to feed about the very door, giving but little heed to the presence of the inmates.

The adults were frequently found paired and the evidence afforded by dissection seemed to indicate that they were breeding. Yet this could scarcely have been the case, since this bird is known to be one of the earliest to nest. Much attachment existed between these mated birds. On one or two occasions the male of a pair being shot first, the female flew only a short distance and remained calling loudly, until the gun was recharged and the tragedy ended by placing her beside her mate.

Only once was the species heard to sing and then (Aug. 5) it was but snatches of an apparently pleasing song.

38. Chrysomitris pinus, (*Wils.*) *Bp.* Pine Linnet.—Common. A tame, familiar species, going at this season of the year in small flocks. They fed about a fish house occupied by our party at Grand Marais, and frequently ventured *under* the building in their search for food.

39. [Chrysomitris tristis, (*Linn.*) *Bp.* Thistle Bird.—Found at Duluth in July, 1877.]

40. [Passerculus savanna, (*Wils.*) *Bp.* Savanna Sparrow.—Rather common about the fields below Duluth in July, '77.]

41. [Pooecetes gramineus, (*Gm.*) *Bd.* Grass Finch.—Common at Duluth, July, '77.]

42. [Melospiza palustris, (*Wils.*) *Bd.* Swamp Sparrow.—Duluth, common, July, '77.]

43. Melospiza meloda, (*Wils.*) Bd. Song Sparrow.—Abundant in every suitable locality. Minnesota Point, Sept. 1. Grand Marias, July 28; Aug. 13, etc.

44. [Junco hyemalis, (*Linn.*) *Scl.* Snow Bird.—Found common at Duluth in July, '77; but not noted at any point this summer.]

45. Spizella socialis, (*Wils.*) *Bp.* Chipping Sparrow.—A common species all along the shore and abundant at some more than usually suitable localities, as on Minnesota Point and about Grand Marais. Attending to young in early part of August. Grand Marais, Aug. 13.

46. Zonotrichia albicollis, (*Gm.*) *Bp.* White-throated Sparrow.—Common; rather shy; frequenting the thick brush and raspberry patches of burnt areas. A brood of young just able to fly and accompanied by the parent, was found at Grand Marais, Aug. 21. This, however, was exceptionally late. In song quite generally during the first week of August. From this time onward the singing gradually decreased until during the last week of the month it was only occasionally that the full song was heard.

47. Goniaphea ludoviciana, (*Linn.*) *Bowd.* Rose-breasted Grosbeak.—A single individual seen a short distance below Burlington Bay, Aug. 30.

48. [Cyanospiza cyanea, (*Linn.*) *Bd.* Indigo Bird.—Seen several times at Duluth, July, '77.]

49. Dolichonyx oryzivorus, (*Linn.*) *Sw.* Bobolink.—Heard flying over at Beaver Bay, Aug. 27, and [a male seen near Duluth, July 17, '77.]

50. Molothrus pecoris, (*Gm.*) *Sw.* Cow Blackbird.—A single specimen taken at Grand Marais, July 29. It was flying high in the air and alighted in the very top of a tall pine.

51. Agelæus phœniceus, (*Linn.*) *Vieill.* Red-winged Blackbird.—Small flocks of immature birds were seen occasionly. They must have been bred elsewhere, as this region is entirely unsuited to their nesting habits. First seen at Poplar River, Aug. 4-7; two taken at Grand Marais Aug. 19, and common at Beaver Bay, Aug. 26 29.

52. Quiscalus purpureus, (*Bart.*) *Licht.* Purple Grackle.—Noted but twice, once at Beaver Bay and once at Duluth.

53. Corvus corax, *Linn.* Raven.—Common. Residents say they are very numerous during the winter.

54. Corvus americanus, Aud. Crow.—Common at Duluth, Aug, 31—Sept. 2; but seen only occasionally further down the shore. Duluth, Sept. 1.

55. Cyanurus cristatus, (*Linn.*) *Sw.* Blue Jay.—Aparently uncommon. Seen near Cascade River, and again near Stewart River, and heard several times at Devil's Track Lake.

The Canada Jay (*Perisoreus canadensis*) is reported both by the white residents and the Indians, as common here, but none were seen by us.

56. Tyrannus carolinensis, (*Gm.*) *Temm.* King-bird.—Observed first at Grand Marais, Aug. 20, where two specimens were taken and several others seen. At Beaver Bay, but not common. [Common at Duluth in July, 1877.]

57. Sayornis fuscus, (*Gm.*) *Bd.* Phoebe Bird.—One taken at Grand Marais, Aug. 20, and a pair seen at Duluth, Aug. 31.

58. Contopus borealis, (*Sw.*) *Bd.* Olive-sided Flycatcher.—First seen Aug. 19 at Grand Marais. Five shot Aug. 20, when it was common on tops of talls trees in an old partial clearing. This species, together with the king-bird, appeared suddenly in a locality which had been under close inspection for some time previously.

59. Empidonax trailli, (*Aud.*) *Bd.* Traill's Flycatcher.—Taken at Beaver Bay, Aug. 27. [A female, whose actions seemed to indicate that it had young, was shot in a willow thicket at Duluth, July 13, '77.]

60. Empidonax minimus, *Bd.* Least Flycatcher.—Apparently common. Poplar River, Aug. 5. Grand Marais, Aug. 20.

61. Empidonax flaviventris, *Bd.* Yellow-bellied Flycatcher.—A pair taken at Poplar River, Aug. 6.

62. Chordeiles virginianus, (*Gm.*) *Bp.* Night Hawk.—Common in the latter part of August, when they were migrating in loose flocks.

63. Chetura pelagica,) *Linn.*) *Bd.* Chimney wift.—Generally distributed, but nowhere observed to be common, except at Duluth, in July, 1877. Aug. 5, a nest containing three young birds about two days old, was found in an abandoned house at Poplar River. The birds entered through a stove-pipe hole in the roof, and had glued their nest to the vertical boards of one end of the attic. Seen at Devil's Track Lake, Aug. 16. It must breed almost exclusively in the hollow trees.

64. Trochilus colubris, *Linn.* Ruby-throated Humming-bird.—Taken at Grand Marais, July 29, and seen at Beaver Bay, Aug. 29.

65. Coccygus erythrophthalmus, (*Wils.*) *Bp.* Black-billed Cuchoo.—Grand Marais, Aug. 13 and 19. One seen at Beaver Bay, Aug. 27.

66. Picus villosus, *Linn.* Hairy Woodpecker.—Occasional. Grand Marais, Aug. 20.

67. Picus pubescens, *Linn.* Downy Woodpecker.—Rather common. Grand Marais, July 29.

68. Picoides arcticus, (*Sw.*) *Gray.* Arctic Woodpecker.—Taken at Grand Marais, Aug. 21, and seen at Black Point, Aug. 24. [Duluth, July 16, '77.]

69. [Melanerpes erythrocephalus, (*Linn.*) *Sw.* Red-headed Woodpecker. —A single individual seen at Duluth, July 11, '77.]

70. Colaptes auratus, (*Linn.*) *Sw.* Golden-winged Woodpecker.—Duluth, Sept. 1. Not noticed elsewhere; but its occurrence at Grand Marais during the migrations is reported by residents.

71. Bubo virginianus, (*Gm.*) *Bp.* Great Horned Owl.—Heard at night on several occasions, and a specimen secured at Grand Marais, Aug. 20.

72. Syrnium nebulosum, (*Forst.*) *Boie.* Barred Owl.—A medium sized owl, seen at Poplar River on the evening of Aug. 4, may have been this species.

73. [Accipiter fuscus, (*Gm.*) *Gray.* Sharp-shinned Hawk.—Seen at Duluth, July 16, '77.]

74. Astur atricapillus, (*Wils.*) *Jard.* American Goshawk.—A single (female?) bird of the year taken at Little Marais, on Aug. 26.

75. Falco communis, *Gm.* Poregrine Falcon.—At a point about two miles below Poplar Piver, where the shore of the lake is a rocky cliff surmounted by thick trees, a pair of these birds was seen Aug. 4. As we passed the place in a boat they circled about over the woods and water, uttering repeatedly short, harsh screams and seemed greatly agitated by our presence. Was it possible for them to have had young at that late date? Their actions certainly indicated that they had. A second pair, which, upon our intrusion upon their domain, acted in much the same excited manner, was seen Aug. 25 on the summit of Carlton's Peak, and a single individual was observed Aug. 24 about the high, jagged precipice of the "Saw-tooth" at Black Point.

76. Falco columbarius, *Linn.* Pigeon Hawk.—Taken at Grand Marais Aug. 13, and seen at Beaver Bay.

77. Falco sparverius, *Linn.* Sparrow Hawk.—Very common; especially numerous in burnt localities, where it perches on the dead trees. Feeds here largely on grasshoppers, as is its habit elsewhere.

78. Buteo pennsylvanicus, (*Wils.*) *Bp.* Broad-winged Hawk.—Grand Marais, Aug. 19, (young bird.)

79. Pandion haliaëtus, (*Linn.*) *Cuv.* Fish Hawk, Osprey.—Seen at Grand Marais, Poplar river and Duluth. These birds lived apparently in the range of hills back from the shore, and came to the lake at intervals to catch fish.

80. Aquila chrysaëtus, *Linn.* Golden Eagle.—A fine adult specimen, killed at Grand Marais in the fall of 1877, was presented to the survey this summer by Messrs. Thomas and Henry Mayhew, of Grand Marais.

81. Haliaëtus leucocephalus, (*Linn.*) *Sav.* Bald Eagle.—None seen, but a pair reported to have bred the present season at a point a number of miles inland from Grand Marais.

82. Cathartes aura, (*Linn.*) *Ill.* Turkey Buzzard.—A specimen procured by Prof. C. W. Hall, at Grand Marais, in Oct. 1878, is in the University Museum. Not noted this year.

83. Ectopistes migratoria, (*Linn.*) *Sw.* Wild Pigeon.—An occasional pair noted during the early part of August, and flocks of considerable size toward the last of the month. Grand Marais, Aug. 9.

84. Bonasa umbellus, (*Linn.*) *Steph.* Ruffed Grouse.—Several covies seen. In the middle of August the young were little more than half grown. Devil's Track Lake, Aug. 16.

85. [Ægialites vocifera, (*Linn.*) *Bp.* Killdeer Plover.—Noted at Duluth in July, '77.]

86. Lobipes hyperboreus, (*Linn.*) *Cuv.* Northern Phalarope.—A single female, taken Aug. 29, by Prof. N. H. Winchell, a few miles above Beaver bay. It was alone, swimming in the lake, at some distance from the shore.

87. Ereuntes pusillus, (*Linn.*) *Cass.* Semipalmated Sandpiper.—Mouth of Devil's Track river, Aug. 21.

88. Tringa Minutilla, *Vieill.* Least Sandpiper.—Common; frequenting in place of the unsuitable shingle beaches, the perfectly bare and smooth rocky shore.

89. Tringa bairdii, *Coues.* Baird's Sandpiper.—Two specimens taken at Grand Marais, Aug. 22. Together with one or two others of the species and several Least Sandpipers, they were feeding on the wet rocks, seeming to find abundant food in the path of every retreating wave.

90. Tringa alpina americana, *Cass.* Black-bellied Sandpiper.—A single individual seen on Aug. 30, near Agate bay.

91. Totanus flavipes, (*Gm.*) *Vieill.* Lesser Telltale.—Common; in small flocks on the beaches. Grand Marais, July 28.

92. Totanus solitarius, (*Wils.*) *Aud.* Solitary Sandpiper.—Rather common. A small shallow pond, full of fallen trees and brush, was their favorite resort at Grand Marais. Grand Marais, July 29.

93. Tringoides macularius, (*Linn.*) *Gray.* Spotted Sandpiper.—Common. Seen at Devil's Track Lake, Aug. 18. Duluth, Sept. 1.

94. [Botaurus Minor, (*Gm.*) *Boie.* American Bittern. Seen at Duluth in July, '77,] and heard of at Grand Marais this year.

95. Porzana carolina, (*Linn.*) *Cab.* Carolina Rail.—Common, though the almost entire absence of marshes forces the species to frequent what seem very unsuitable places. For instance, the dense raspberry patches of burnt sections, thick brush, a pea patch, the rank grass about abandoned habitations, and like curious localities. Once I found three quietly reposing several feet from the ground in an evergreen tree standing in a perfectly dry, stoney location; and on another occasion shot a specimen from the smaller branches of a tree, where it had alighted upon being flushed from a weed-patch on a dry hill side. Grand Marais, Aug. 20. Poplar River, Aug. 5. Beaver Bay, Aug. 27.

97. Anas boschas, *Linn.* Mallard.—Mouth of Devil's Track River, Aug. 20.

98. Querquedula discors, (*Linn.*) *Steph.* Blue-winged Teal.—Two seen in Grand Marais harbor, Aug. 22.

99. [Aix sponsa, (*Linn.*) *Boie.* Wood Duck.—Flock of six seen in Superior Bay, Duluth, July 13, '77.]

100. Mergus merganser, *Linn.* Goosander.—Apparently common. A large brood seen several times on Devil's Track Lake. When alarmed they fluttered along over the surface of the water for a long distance, uttering loud cries. They retreated occasionally down the river and probably came up to the lake for the purpose of fishing. (Possibly *serrator*, as no specimen was secured.)

101. Mergus cucullatus, *Linn.* Hooded Merganser.—A single female seen at Grand Marais, July 28.

102. Larus argentatus, *Brünn.* Herring Gull.—Abundant. They are said to breed on two small rocky islands near Grand Marais. Stomach of one specimen found full of grasshoppers which it had probably picked up from the surface of the water for these insects perish in the lake in countless numbers. Grand Marais, Aug. 12.

103. Larus delawarensis, *Ord.* Ring-billed Gull.—Common. Grand Marais, Aug. 19.

104. Colymbus torquatus, *Brünn.* Loon.—Common.

105. Podilymbus podiceps (*Linn.*) *Lawr.* Pied-billed Grebe.—A specimen taken by Prof. Hall in the fall of 1878. A species of grebe, probably *P. podiceps*, was occasionally seen on the lake the present season.

T. S. ROBERTS.

MINNEAPOLIS, MINN., Dec., 1879.

APPENDIX A.

[FROM THE AMERICAN JOURNAL OF SCIENCE, VOL. XIX, FEBRUARY, 1880.]

On Lintonite and other forms of Thomsonite: A preliminary notice of the Zeolites of the vicinity of Grand Marais, Cook County, Minnesota;

BY S. F. PECKHAM AND C. W. HALL.

Grand Marais is situated on the northwest coast of Lake Superior, one hundred and eight miles northeast of Duluth. It is the site of an early French trading or mission station, and was later a station of the Hudson Bay Company. Its beautiful land-locked bay furnishes the only good harbor between Duluth and Pigeon Point.

The rocks, for several miles east and west, as well as at the Marais, are classed in general as igneous, and have often a basaltic structure. They present, however, great diversities of character both to the chemist and lithologist; and while the mineral species are perhaps altogether old, the forms are in some cases new. It was our original intention to confine this research to one or two peculiar forms that first attracted our attention, but in the progress of our examination the subject has outgrown its earlier proportions, both as regards its extent and the time required for its successful completion. We have therefore concluded to give in the present paper some general observations with such details as are at present in hand, reserving others until further study and analyses shall have rendered the work more complete.

At Good Harbor Bay, about four miles to the westward of Grand Marais, there begins a bed of dark colored rock, highly decomposed at surface, and related to diabase in its lithological characters. This bed extends westward along the coast for several miles, sloping gently from the wooded hilltops a mile or two inland, and disappearing beneath the waters of the lake In its fresher parts the rock is somewhat mottled where coarsest, and nearly black with a greenish tinge where finest in texture. It is only from the talus, under the wall of rock rising above an underlying sandstone outcrop in Good Harbor Bay, that this fresh material can be easily obtained. Even here the mottled appearance discloses the partial decomposition of the most perishable of the constituents, and the formation of some new viriditic mineral. The lower layers are firm and compact, while the upper are extensively jointed and fractured, and filled with amygdaloidal cavities, These cavities, in whatever manner they were originally formed, have

become filled with zeolitic minerals. Some of the cavities are now empty, but evidently as a result of the removal of their contents by solvents percolating through the enclosing rock. Occasionally the cavities are only partially filled, and the substance within shows on its surface unmistakable traces of the action of solvents. In some cavities one mineral is nearly all washed away, leaving the surface of the remaining one or several, as the case may be, rough or uneven, as originally formed. This occurs only where water has had access.

The prevailing mineral, thomsonite, is only sparsely distributed in the lower and compacter beds of the formation. The general occurrence of the several other minerals, so abundant here, would seem to indicate that this mineral was formed first of all from the decomposition of the rock, and that one of the others owes its origin in part at least to the decomposition of those that were formed before it. In many masses of the rock where much exposed and weathered the matrix has been so decomposed as to be easily broken away from the amygdules, but in the fresher portions the fractures extend across them. The other zeolites, being less persistent than the thomsonite, rapidly disappear, while the amygdules of this mineral remain upon the narrow beaches of this vicinity in the form of pebbles of various sizes, frequently unbroken and beautifully polished.

The cavities containing thomsonite are in many places exceedingly numerous, and in other cases few in number, even in the same bed of rock. The size varies from a microscopic point to a diameter of two or three inches. In one piece of the thomsonite-bearing rock, now in the General Museum of the University of Minnesota, the number of amygdules distinctly visible to the unaided eye on a surface two inches square is sufficient to give more than 10,000,000 to the cubic foot. The largest in this area was about half an inch in diameter. The amygdules are generally much larger and more scattered than this specimen would indicate. Since they abound in the rock throughout many feet of its thickness and many miles of its extent along the shore, the supply appears to be inexhaustible; but practically the number of beach-pebbles, valuable as specimens, is quite limited. All the different varieties of thomsonite are so hard that they take a fine polish; and on account of this property and their often unique banded structure, they are much sought after by tourists and others as objects of rare beauty, and also for buttons, studs, etc.

On our first visit to the beach where the greater number of these pebbles occur, we at once recognized fragments of the large amygdules as thomsonite. Intermingled with these were spherical and oval pebbles, often more or less flattened, and of all sizes from that of a pin's head to that of a hickory nut, but for the most part of the size and form of beans and peas. Some of these were also recognized as thomsonite. The larger portion presented a great diversity of color and physical structure; some being white and opaque, almost conchoidal in fracture, with but slight indications of a fibrous structure; others flesh-colored throughout, hard and fibrous, resembling thomsonite from the Tyrol and other localities except in their greater hardness and finer texture; others coarser, closely resembling the mineral from other localities; others, curiously banded externally with zones and annular spaces of red, green, pink and white; and still others, opaque and chrome-green in color, shading out in some to colorless and

translucent with a conchoidal or uneven fracture. These last were at first supposed to be fragments of prehnite, rounded by attrition. On further examination a number of the green pebbles were found to have a fibrous and flesh-colored interior with a shell of the amorphous green mineral. In given portions of the rock formation, the amygdules were, for the most part, of the same general character; in one place, being green and opaque; in another, without green bands; while in another, for the most part, beautifully variegated. Similar local peculiarities were observed in reference to texture, some portions of the rock containing only those that were hard and fine grained, while others those that were uniformly coarser in texture.

In our examinations of the amygdules, we designated the opaque white variety, Number *one* (I), the ordinary thomsonite, Number *two* (II), and the *green* varieties, Number *three* (III).

As regards hardness, the thomsonite—in nearly all its varieties—is peculiar Some fibers scratch quartz, which indicates a hardness above 7; but this may be owing to the presence of free silica. The harder specimens of Nunber III scratched an agate mortar easily, but were scratched by quartz crystal; yet the percentage of silica was found to be no higher in the harder than the other specimens. The grain of such specimens, however, is exceedingly fine. Most frequently the hardness is between 5 and 6. The specific gravity varies from 2.33 to 2.35; the water-worn and somewhat weathered pebbles have it a little lower, one or two as low as 2.2. The fracture of Numbers I and II is fibrous; of Number III very uneven, and takes place in all directions with almost equal facility. They all gelatinize in hydrochloric acid to a thick jelly. Before the blowpipe they fuse easily and intumesce to a porous white enamel. In the closed tube, water to the amount of 11 to 12 per cent. of the whole weight was given off at the heat of an ordinary spirit lamp. Grains of native copper are frequently found in them, particularly in those of Number III, which, if the pebbles are transparent, exhibit under a low magnifying power arborescent groups of crystals, thrusting out their branches in every direction through the enclosing mineral. In one instance an amygdule, about as large as a cranberry, contained at its center a mass of copper of this kind, one-third of its diameter. In this characteristic Number III resembles the prehnite of French River.

Number I.—The amygdules of this type are perhaps of less common occurrence than other forms. Externally they look like porcelain with a slight creamy tint. Under the microscope they appear for the most part translucent. Countless fine dark lines extend longitudinally through the thin section, rapidly disappearing to be replaced by others, like the cells in a longitudinal section of wood, which are probably caused in part by refraction of the light from the edges of minute densely packed crystals, from cavities, and from microlites. One noticeable result of these lines is to weaken the effect of the mineral on polarized light. Not infrequently this opaque modification of the mineral is banded with alternating zones, either transparent or yellow, or even with both; the transparency here seems to be owing to an absence of the lines and microlites just noticed; while the yellow zones owe their color to globules of ferric oxide distributed through the mass. In the worn amygdules the mineral often has a beautiful pearly

lustre. In minute quantities the ferric oxide gives the mineral a flesh-colored tint.

A mean of three analyses showed the composition of this mineral to be:

SiO_2	40.45
Al_2O_3	29.50
Fe_2O_3	0.232
CaO	10.75
K_2O	0 357
Na_2O	4.766
H_2O	13.93
	99.985

Even opaque *white* amygdules afforded a trace of ferric oxide, which increased to a few hundredths of one per cent. when the tint was perceptibly flesh-red.

Number II.—Under this type nearly every specimen is fibrous and radiated. The masses are spherical or elliptical, with the point from which the crystalline fibers radiate on one side of the mass, or, as is perhaps more common, having several centers of radiation within the compact mass. Occasionally the mineral fills seams, or occupies cavities that run together; here, there are centers of radiation at frequent intervals and by a system of suture-like joints, the whole is made into a compact mass. Yet, solid as the mass may appear to be, a thin plate cut from it invariably separates into pieces along the line of these joints, giving the mineral an appearance of fragility while it is really as hard as agate. The fibers often interlock along the line of these joints.

At the outer extremity of many of these radiated concretions, there often occur many transparent needles, large enough to be seen with the unaided eye, extending backward along the direction of the fibers toward the center of radiation. These needles are broken up into short pieces by transverse fractures. They all taper out and disappear, the longest of them reaching no further than the middle of the mass. They act strongly on polarized light and contain some inclusions. These lines do not occur as developed crystals.

Around the borders of many amygdules there are numerous small sphærolites. They have probably formed around granules of various foreign substances as nuclei. Their size is small; to the naked eye they look like mere spots, but they are so numerous as to form an envelop almost entirely around the radiated concretions.

A mean of three analyses gave—

SiO_2	46.020
Al_2O_3	26.717
Fe_2O_3	0.813
CaO	9.400
K_2O	0.390
Na_2O	3.756
H_2O	12.800
	99.896

Number III.—As before stated, these pebbles, when first seen, were supposed by us to be worn fragments of reniform prehnite, so common in several localities along this shore. We soon found evidence that they were amygdules; still the fact that they were not prehnite was not suspected until their specific gravity had been determined and found to be that of thomsonite, 2.32 to 2.37. Analysis showed them to contain—

SiO_2	40.605
Al_2O_3	30.215
FeO	.40
CaO	10.370
K_2O	.49
Na_2O	4.055
H_2O	13.75
	99.885

This composition allies the mineral very closely to thomsonite, so closely that, considered alone, there appears little reason why the mineral should not be considered as a variety; but there are several notable reasons why a specific name may properly be applied to this, as we believe, hitherto undescribed mineral.

These pebbles are wholly destitute of the radiated and crystalline character of other forms of thomsonite. Under the microscope the texture is wholly granular so that the crystalline system cannot be determined; and the granules are so fine and so compactly arranged in many specimens that they can be resolved only in polarized light. Their size, however, is not uniform in the same pebble, being so fine in some places that only a high power will make them visible.

Sphærolites are also frequent; but unlike their mode of occurrence in the thomsonites, they are distributed almost at random in any part of the amygdules containing them; and frequently some foreign material, as a bit of copper, is a nucleus. The sphærolites often occur in groups; large numbers are crowded and heaped together, growing into and overlapping one another, like the tridymite scales in the rhyolites of Mexico and the trachytes of the Siebengebirge. These groupings are not always spherical; sometimes they extend in long curving lines through the mass, following perhaps a fracture or a seam, instead of being collected around a nucleus as a sphærolite. They show parallel green fibers meeting along a median suture and correspond in their manner of occurrence to Zirkel's description of axiolites in the rhyolites of the 40th parallel.*

The amygdules of the green variety rarely exceed in size a small hickory nut. As before stated, they are not generally found intermingled in the rock with the other forms, but have special localities—they filling nearly all the amygdaloidal cavities within a given limit, whose boundary at the same time is not sharply defined. Frequently the forms of No. I or II are enveloped in a green covering of considerable thickness. Moreover, the amygdules of this type uniformly contain ferrous oxide in small but varying proportion in combination, whereas in Numbers I and II the microscopic

* U. S. Geol. Explor. 40th Parallel, vol. vi, p. 166 et seq.

sections show the ferric oxide to be segregated in minute particles or patches mechanically distributed through the fibrous mass; and in many amygdules these particles can be seen distinctly even with the unaided eye. Nor can Numbers I and II be considered as altered forms of Number III, as the condition of the iron might indicate. No amygdule has come under our observation which exhibited a nucleus of Number III, surrounded by Number I or II. On the contrary, we have quite a number in which, through a thin translucent shell of Number III, the pink interior can be discerned. And we also have fragments, and amygdules have been cut, which show the external crust of Number III passing toward the center into the radiated form of Number II.

In determining the oxygen ratio for Number II, the silica appeared to be too high. We had previously suspected the presence of free silica from the exceptional hardness of all of these varieties. As the microscope showed the ferric oxide in every case to be free, we concluded to compute the percentages for Number II to 40.45 per cent. of silica, the amount found in Number I, and exclude the iron oxides. We were much surprised at the results, which are given below:

	I.	II.		III.
SiO_2	40.45	40.45		40.605
Al_2O_3	29.50	29.37		30.215
CaO	10.75	10.43		10.37
K_2O	0.36	0.42		0.49
Na_2O	4.76	4.28		4.05
H_2O	13.93	13.93		13.75
	99.75	98.88		99.48
Fe_2O_3	0.23	0.88	FeO	.40
	99.98 pr. ct.	99.76 pr. ct.		99.88 pr. ct.

These figures prove conclusively that we were dealing with varieties of the same mineral. On comparing these percentages with those given in Dana,* the water and silica were found to be high.

Computing the oxygen ratios and formula for Number III, we have

	Per cent.	Metal.	Oxygen.	Atoms.
FeO	0·40	0·3111	0·0889	·0064
K_2O	0·49	0·4068	0.0832	·0052
Na_2O	4·055	3·0118	1·0432	·0654
CaO	10·37	7·4070	2·9630	·1852
			4·1783 R.	·2622
Al_2O_3	30·215	16·1343	14·0807	·2933
SiO_2	40·605	18·949	21·656	·676
H_2O	13·75	1.528	12.222	·765

Dividing the oxygen percentages by 5, we have

$$RO : R_2O_3 : SiO_2 : H_2O = 1 : 3 : 4 : 2\tfrac{1}{2},$$

which is the ratio for thomsonite, given in Dana's Mineralogy, with the

* System of Mineralogy, fifth edition, p. 425.

bases low and the silica and water high. Dividing the atoms by ·005, we have the formula

$$(2{\cdot}5(FeO+K_2O+Na_2O)+3{\cdot}5CaO)Al_2O_3,\ (SiO_2)_2\ (H_2O)_3,$$

with the protoxide bases low, and the silica and water high.*

Computing the ratios after Rammelsberg) we have:

$(Na+K):(Ca+Fe)::1:1{\cdot}35$
$(Ca+Fe):Al_2::1:154$
$(Ca+Fe+K+Na)=R:Al_2:Si::1{\cdot}13:1:2{\cdot}03$
$Si:H::1:2{\cdot}26$

Rammelsberg deduces from these ratios a formula which he calls a half silicate (Halbsilicat), according to the expression

$$\left\{\begin{matrix} m\,(2Ca\ \ Al_2\,Si_2\,O_8+5aq) \\ n\,(2Na_2\,Al_2\,Si_2\,O_8+5aq) \end{matrix}\right\}\dagger$$

in which m indicates a certain proportion of a hydrous silicate of aluminum and a dyad protoxide, and n a certain proportion of a hydrous silicate of aluminum and an alkaline or monad protoxide. The ratio between m and n varies in different specimens. Number I and Number II, without the excess of silica, approach more nearly the thomsonite of Elbogen in composition (in which the ratio of m to $n=2:1$) than any mentioned by Rammelsberg. While the ratio of Si to H is about the same as given by Rammelsberg, the percentage of both in these specimens is higher than in the analyses quoted by him.

We conclude, therefore, that this mineral contains a small percentage of free silica, and also that a part of the water is basic. This latter opinion is strengthened by the fact that about 12 per cent. of the water escaped at a dull red heat, and that only prolonged heating in a platinum crucible for several hours would expel the last 1·75 per cent. At least six determinations of the water were made in this variety, with the same result.

The percentages of Numbers I and II are so near that of Number III that no material difference can exist in their formulæ. While recognizing this fact as respects the chemical constitution of these minerals, the great difference in their physical structure leads us to regard Number III as a distinct and well marked variety of thomsonite, if not a distinct species. We have therefore given it the name *Lintonite*, in honor of Miss Laura A. Linton, a recent student and graduate of this University, to whose patient effort and skill we are indebted for the analyses given in this paper.

UNIVERSITY OF MINNESOTA, Nov. 20, 1879.

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* Fifth edition, p. 425.

† Rammelsberg Min. Chem., Ed. 1875, p. 637.

APPENDIX B.

CORRESPONDENCE WITH THE UNITED STATES GEOLOGICAL SURVEY.

[Telegram.]

WASHINGTON, Feb. 28, 1880.

Prof. N. H. Winchell, State Geologist, Minneapolis:

During the coming spring it is probable that congress will determine the question whether or not the surveys shall be extended over the whole area of the United States. It is not the policy of this organization to make surveys of States, but simply to follow such general questions as happen at any time to be under investigation wherever the facts may lead, regardless of political lines. An erroneous impression of the policy of this bureau having been industriously circulated, the director desires to announce to you that he urges the inauguration and continuance of State surveys, and wishes to co-operate with them, to the mutual advantage of both parties. He desires to ask whether or no, in your opinion, such general extension of this survey is desirable to meet the practical and scientific needs of the people and the Government, and whether you would wish to co-operate with him. Please reply very fully by telegraph.

CLARENCE KING.

[Telegram.]

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, MINN., Mar. 1, 1880.

Clarence King, Director of the United States Geological Survey, Washington, D. C.:

The general extension of the United States Geological Survey over the whole area of the United States is, in my opinion, desirable for the following reasons:

1. It will give it full data for the discussion of questions that arise in one part and cannot be settled without examinations in other parts.

2. The need of geological science in America is a systematic and authorized adjustment of a great many questions that have been variously

answered by the various local geologists of the States, principally because of restricted areas of examination. Such an extension of the United States Geological Survey would ultimately harmonize a great many apparent discordances that now exist, and would redound to the advancement of the science, and the general acceptance of its truths among the people.

3. There are some States, as well as Territories that never have completed geological surveys, and perhaps never will. Yet a knowledge of this geology is essential to the interpretation of the geology of adjoining States, particularly when they isolate those adjoining States from the before-surveyed areas of the Union. There should be some agency for surveying such areas of the Union. The geological relationships between the States is as intimate as the hydrographic, or the climatic, or the sanitary, or the commercial; and the general "practical and scientific needs of the people" just as much require their examination, interpretation and full publication.

4. I have no sympathy whatever with the alarming cry of *States rights*, as against such a general extension of the United States Geological Survey. The history of the past century has sufficiently established the national character of the United States. It is pre-eminently a nation's duty to survey and map, and develop its domain, whether held by private parties or not; and our Government has recognized this duty in a great many ways. It has established hydrographic, magnetic, geoditic, climatic, ethnologic, astronomic, topographic and other surveys and investigations of a national character, in one way and another, which are as likely to trespass on the rights reserved to the States as anything connected with a geological survey.

5. The older States that have been surveyed, ought to be re-surveyed. The development of the country is so rapid that new geologic facts are constantly being exposed, bearing on a knowledge of the strata and their contents. This is in the nature of science. It is no fault of the early geologists. This necessity is so apparent that in several of the older States such re-surveys have already been undertaken.

6. The aggregate cost to the United States of a uniform general survey, of the character and completeness that the United States government would execute, would certainly be much less, and the survey would be much quicker done than if each State should institute its own survey and invest in apparatus and outfit and carry it on independently.

On the other hand, the general extension of the United States Geological Survey over the whole area of the United States, would result disastrously in the following ways, unless special provision be made against them:

1. Reducing the number of scientific investigators and observers, by the absorption of their functions and duties into the general United States Survey, and hence the decadence of general popular knowledge of, and interest in, scientific matters.

2. The removal of specimens and material for museums from the States to the national capital, and hence the injury of the States themselves by compelling the citizen to travel often a great distance to examine his home products.

3. In an educational sense, the loss to the State of those incentives, methods and means of scientific knowledge which are derived from the geological examination of the State.

4. The interference with, and final termination of, the present and the prevention of future State geological surveys.

If a law can be framed that will carry out the former considerations, but guard against the latter, I should be in favor of it, and should be glad to co-operate with such a United States Geological Survey.

The mere extension of the present U. S. Geological Survey, for the purpose of certain economical investigations over the whole area of the United States, is not only very desirable, but almost necessary for the satisfactory elucidation of our national material wealth, making a kind of geological census; and I shall be glad to co-operate in every way in my power. It seems to me that a law could be framed that would allow the States, through their State Universities, a large latitude in the control of the material gathered, and in the educational interests involved, but which would still place the general supervision, direction and publication at Washington.

Yours very respectfully,

N. H. WINCHELL.

APPENDIX C.

[EXTRACTED FROM THE AM. JOUR. OF SCIENCE AND ARTS FOR JUNE, 1880.]

Study of the Emmet County Meteorite, that fell near Estherville, Emmet County, Iowa, May 10, 1879.

BY J. LAWRENCE SMITH, LOUISVILLE, KY.

The fall of this meteorite is in all its attendant circumstances one of the most remarkable on record. I therefore visited the region, on my return to America some months after its fall, and saw the two large masses which are the main representatives. Several short notices have already appeared on the subject; among them, one each, by Professor Shepard, Professor Peckham and Professor Hinrichs; and in describing the physical and chemical characteristics of the original masses, I shall be obliged to repeat some details that have been brought out.

Locality.—The place of fall is near Estherville, Emmet County, Iowa, just on the boundary of the State of Minnesota, lat. 43° 30′, lon, 94° 50′, within that region of the United States which has become remarkable for falls of meteorites, and of which I gave an outline map in my article on "the three meteorites that fell at Rochester in Indiana, Cynthiana in Kentucky, and Warrington in Missouri, within the space of one month."*

The State of Iowa has become particularly conspicuous in recent years as the landing place of these celestial messengers; and I now have under examination still another remarkable one with some peculiar physical characters, but about which I have not yet obtained the historic details.

The *phenomena accompanying the fall* were of the usual character, but on a grander scale. It occurred about five o'clock in the afternoon, under a clear sky, with the sun shining brightly. In some places the meteorite was plainly visible in its passage through the air, and looked like a ball of fire with a long train of vapor or cloud of fire behind it, and one observer saw it 100 miles from where it fell. Its course was from northwest to southeast. The sounds produced in its course are referred to as being "terrible" and "indescribable," as scaring cattle and terrifying the people over an area many miles in diameter. At first they were louder than that of the largest artillery; these were followed by a rumbling noise, as of a train of cars crossing a bridge. The concussion when it struck the ground was sensible

*Am. Journal of Sci. and Arts, Vol. XIV, 1877.

to many persons, and it is reported that the soil was thrown into the air at the edge of a ravine where the largest of the masses was found. Two individuals were within two or three hundred yards of the spots where the two larger masses fell.

There were distinctly two explosions. The first took place at a considerable height in the atmosphere, and several large fragments were projected to different points over an area of four square miles, the largest mass going farthest to the east. Another explosion occurred just before reaching the ground, and this accounts for the small fragments found near the largest mass.

Impact with the earth.—A remarkable fact connected with the fáll, besides that of the local disturbance of the earth alluded to, is the depth to which the mass penetrated. Had the fall taken place during the night, I doubt if the largest fragment would have been found. It struck within 200 feet of a dwelling house, at a spot where there was a hole (previously made) six feet deep and over twelve feet in diameter, filled with water, and having a bottom of stiff clay. This clay was excavated to a depth of eight feet before the meteorite was discovered, and two or three days elapsed before it was reached. Its total depth below the general surface of the ground was hence fourteen feet.

The second large mass was found embedded in blue clay about five feet below the surface, at a place two miles distant from the first. The third of the three largest masses was not discovered until the 23d of February, 1880, more than nine months after the fall, and its locality was four miles from the first. A trapper on the prairies, who had witnessed the original occurrence, observed a hole in a dried-up slough; on sounding it with his rat spear, he detected a hard body at the bottom, and on digging found the stone at a depth of five feet. Some small fragments were doubtless detached when the large mass approached the ground, as they were discovered near to it. The fragments thus far obtained weighed respectively, 437, 170, 92½, 28, 10½, 4 and 2 pounds.

Height and velocity.—A railroad engineer who observed it before the report, estimated its height to be forty miles, but at the time of the explosion much less; from an imperfect computation, he considered its velocity to be from two to four miles per second.

External Characters.—The masses are rough and knotted like large mulberry calculi, with rounded protuberances projecting from the surface on every side: the black coating is not uniform, being most marked between the projections. These projections have sometimes a bright metallic surface, showing them to consist of nodules of iron; and they also contain large lumps of an olive-green mineral, having a distinct and easy cleavage, which is more distinct where the surface has been broken. The greater portion of the stony material is of a gray color, with this green mineral irregularly disseminated through it. The two minerals are mixed under various forms; sometimes the green mineral is in small rounded particles intimately mingled with the gray, at other times it is in small cavities in minute crystalline fragments, without any distinct faces, and almost colorless. The masses are quite heavy and vary much in specific gravity in their different parts; but the average cannot be less than 4.5. When broken, one is immediately struck with the large *nodules* of metal among the gray

and green stony substances, some of which will weigh 100 grams or more. In this respect this meteorite is unique, it differing entirely from the mixed meteorites of Pallas, Atacama, etc., or the known meteoric stones rich in iron; for in none of these has the iron this nodular character.

Another striking feature in the relation of the iron and stony matter is, that the larger nodules of iron appear to have shrunk away from the matrix; an elongated fissure of from one to three millimeters sometimes intervening, separating the matrix and nodules to the extent of one-half the circumference of the latter, and appearing as if the iron had contracted from the stony matrix during the process of cooling. There are numerous small cavities of various sizes, where there are not any iron nodules, and where the minerals appear more crystalline, indicating an irregular shrinkage during the consolidation.

The minerals.—At first sight I expected to find more than two earthy minerals. The microscope gave, as with most meteoric stones, unsatisfactory results. I therefore tried to separate the stony minerals mechanically; the only mineral that I was enabled to obtain pure in sufficient quantity, has an olive green color, and occurs in masses of from one-half to one inch in size, having an easy cleavage, especially in one direction; this is proved to be *olivine*. The same mineral occurs also in minute rounded concretions in other parts of the meteorite; and minute, almost colorless crystalline particles in the cavities I take to be olivine. *Nickeliferous* iron, as already stated, is very abundant. *Troilite* exists in small quantity. *Chromite* was also found.

That the stony part of this meteorite consists essentially of bronzite and olivine will be seen from the chemical investigation, which found only three essential constituents, viz: silica, ferrous oxides and magnesia. Another silicate will be referred to beyond, consisting of the same oxides, but in different proportions from either bronzite or olivine.

Chemical constitution.—The stony part, pulverized and freed as far as possible from metallic iron by the aid of the magnet, when treated with chlorhydric acid on a water bath for several hours, is resolved into soluble and insoluble parts, the proportions varying very much with different fragments, and ranging from 16 to 60 per cent for the soluble part. This soluble part consists of silica, ferrous oxide and magnesia, and without a trace of lime, thus indicating the absence of anorthite.

(1) *Insoluble portion.*—The insoluble portion was carefully analyzed by fusion with carbonate of soda, and found to contain:

		Oxygen ratio.
Silica	54·12	29·12
Ferrous oxide	21·05	4·67
Chromic oxide	trace.	
Magnesia	24·50	9·80
Soda with traces of potash and lithia	·09	·023
Alumina	·03	·013
	99·29	

The oxygen ratio clearly indicates the mineral to be $\ddot{Si}\dot{R}$, being virtually $\ddot{Si}$ ($\dot{M}g\dot{F}e$), or the common form of *bronzite* contained in meteorites.

(2) *Soluble portion.*—On testing the green mineral already referred to I found that this was the soluble portion, and it was readily detected in a pure state from the stony part of the meteorite. Its cleavage in one direction is very perfect; its specific gravity 3·35; hardness almost 7; pulverized, it is readily and completely decomposed by hydrochloric acid. Two analyses were made, one by decomposing it directly with hydrochloric acid over a water bath, and the other by first fusing it with carbonate o soda—the two analyses agreeing perfectly.

		Oxygen ratio.
Silica	41·50	22·13
Ferrous oxide	14·21	3·12
Magnesia	44·64	17·86
	100·35	

The above analysis gives the formula $\ddot{\text{Si}}\dot{\text{R}}_2$, or that of olivine.

(3) *Opalescent silicate.*—In some parts of this meteorite, a silicate occurs that is opalescent, of a light greenish-yellow color, and cleaves readily. In one instance I observed it making a notable projection on the surface. Although I had a number of fragments of the meteorite for examination, amounting to ten or twelve pounds, I did not obtain enough of the mineral to establish positively its true character, but I hope to obtain more. An analysis was made with about 100 milligrams of the pure mineral with the following result:

		Oxygen ratio.
Silica	49·60	26·12
Ferrous oxine	15·78	3·50
Magnesia	33·01	13·21
	98·39	

Equivalent to $\ddot{\text{Si}}\dot{\text{R}}_2 + \ddot{\text{Si}}_2\dot{\text{R}}$, one atom of bronzite plus one atom of olivine, a form of silicate that we might expect to find in meteorites.

(4) *The nickeliferous iron.*—As already stated this iron is abundant in the meteorite, and sometimes in large nodules of 50 to 100 grams; on a polished surface the Widmanstättian figures are beautifully developed by acid. On analysis it was found to contain:

Iron	92·001
Nickel	7·100
Cobalt	·690
Copper	minute quantity.
Phosphorus	·112
	99·903

(5) *Troilite.*—The proportion of troilite is not large, and it could be detached only in small fragments.

(6) *Chromite.*—When small pulverulent fragments of the meteorite are heated with hydrochloric acid for some time and the residual matter washed and dried, it is easy to find particles of the stony mineral more or less filled with minute black shining particles which are chromite.

The constitution of this meteorite, so far as I have been able to make it out, is therefore as follows:

Bronzite, abundant; *olivine*, abundant; *nickeliferous iron*, abundant; *troilite*, in moderate quantity; *chromite*, in minute quantity; *silicate*, not yet well determined.

It will be thus seen that in its composition the meteorite contains nothing that is peculiar. I should, however, give it a unique position among meteorites, on account of the phenomena accompanying its fall, especially the great depth to which it penetrated beneath the surface, and also because of its physical characters and the manner of association of its mineral constituents. I examined carefully for feldspar and schreibersite; but the absence of both lime and alumina (except as a trace) clearly proved the absence of anorthite; and the small particles of the mineral that might have been taken for schreibersite were found on examination in all instances to be troilite.

Emmet County Meteorite:—When my paper was sent to press, the following new facts in connection with this meteoritic fall had not been discovered. I am indebted for them to Mr. Chas. Birge. These additional discoveries, twelve months after the fall, only add to the interest of this phenomenon. Mr. Birge, a few months ago, had been made aware of the fact that a number of boys, herding cattle near a lake about four miles west of Estherville on the day of the fall, reported that when the meteor passed over them, a great shower of what appeared to them hailstones fell, and that the surface of the water was alive with the falling bodies. Three weeks ago (April 15th) the people of that heighborhood began to find, on the freshly burnt prairies, small pieces of meteorites from the size of a pea to one pound in weight; 300 to 500 were thus found; and ten days ago (May 1st) thousands of men, women and children were on the ground daily, and from the meteoric field probably five thousand pieces have already been gathered, making in all a weight of not less than from 60 to 75 pounds.

APPENDIX D.

CASTOROIDES OHIOENSIS, *Foster*.

BY N. H. WINCHELL.

In the city of Minneapolis, while digging for a cistern on the corner of Washington avenue and Fifteenth avenue north, Mr. — Sommers discovered, at the depth of eight feet, the left mandibular ramus of this rare beaver-like rodent. The position is within the Valley of the Mississippi River, and under the sandy loam that lies on the brick clay. Referring to the diagram opposite page 168 of the report for 1876 (fifth report), its position is illustrated. It lay near the bottom of the "sandy, loam-covered, gravelly plain," about twenty feet above the river, and over the brick clay, so near the brick clay that in excavating in search for other pieces, some of the clay was thrown out. Accompanying it were fragments of *Unio* shells. It hence belongs to that period of time when the Mississippi extended between the high drift bluffs that enclose the city of Minneapolis, and which are about two miles apart, and hence to the flood, or "terrace," epoch, of the glacial period. Probably the ice of the glacial period still prevailed over the northern part of the State, its dissolution supplying the abundant water which kept the Mississippi at that stage.

This rodent was first found in the State of Ohio, at Nashport, Licking County, and was described anonymously, but not named, by J. W. Foster, in the American Journal of Science and Arts for 1837, with figures, and subsequently named by him in the 2d Report on the Geology of Ohio, in 1838. It was again found at Clyde, Wayne County, New York, and was described and figured by Wyman in the Proceedings of the Boston Society of Natural History, in 1846. This discovery embraced the right ramus and the entire skull. In the University Museum are perfect plaster casts of these specimens, the original of which are in the museum of Geneva College. The remains of the same animal (ramus of the lower jaw) have been found also at Memphis, Tenn., which were described by Wyman in the Am. Jour. Sci. and Arts for 1850, vol. X, and in the third volume of the Proc. Bos. Soc. (1850); also by Agassiz in Proc. Am. Assc. Adv. Sci. for 1851. Mr. J. Le Conte records its discovery at Shawneetown, Illinois, in the Proc. Phil. Acad. Nat. Sci., vol. VI, p. 53, and J. Leidy notes fragments of teeth from the Ashley River, South Carolina, and a skull near Charleston, Coles County, Ill. Wyman also mentions its discovery near Natchez, Mississippi, and in Louisiana, and A. Winchell records it in Michigan, in the American Naturalist for 1870. J. A. Allen reports it from Dallas, Dallas County, Texas, from the alluvial deposits of the Trinity River, associated with the

remains of an extinct horse and mastodon, in the Monograph on Rodentia (vol. XI) of the United States Geological Survey of the Territories, by F. V. Hayden. It seems, therefore, to have been extended over the whole of the United States east of the Mississippi from Minnesota to Louisiana, and into Texas, and to have been cotemporary with the mastodon, and hence with the mound builders. It was, however, quite different from the living beaver, and may not have been acquatic. No portions of the skeleton except the head and teeth have been discovered. Its size was about that of the common black bear, according to Mr. Allen, and it was wholly a vegetarian.

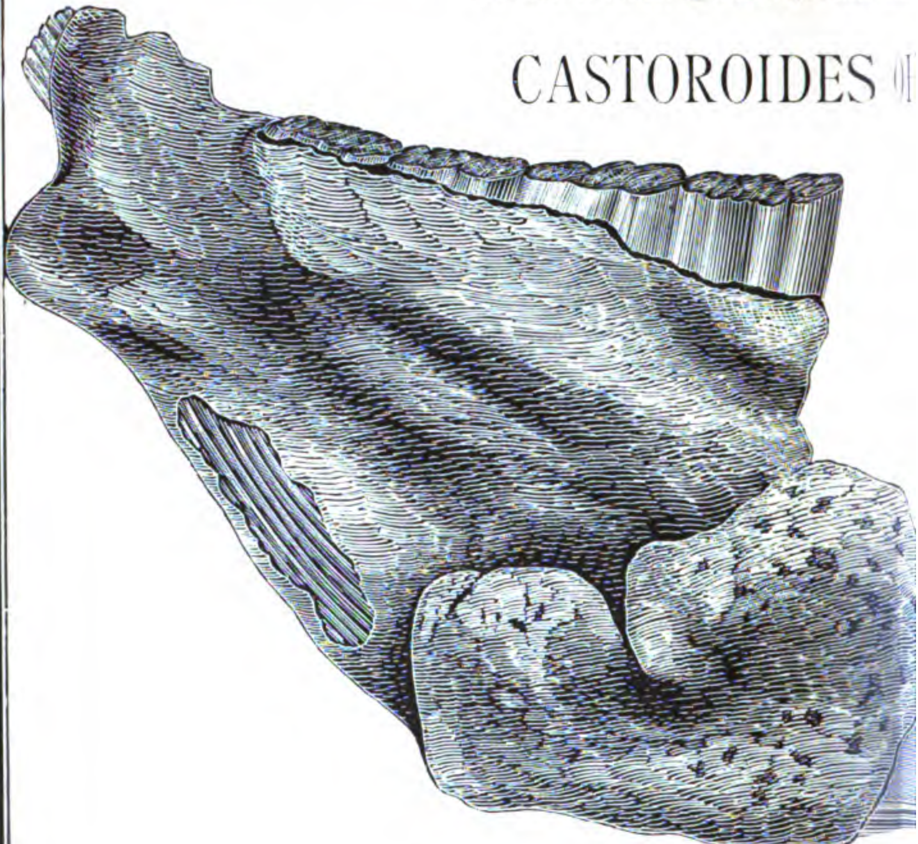
The specimens found at Minneapolis consist of the left ramus and the lower left incisor, the latter evidently broken from the former in being removed from the sand in which the whole was entombed. Their size indicates an animal somewhat larger than the specimen first found in Ohio and described by Foster, and also larger than that found in New York. It is, however, a little smaller than that described by Wyman from Memphis. The whole length of the specimen, when the parts are united, is 9½ inches, of which 5¼ inches consist of the projecting, uncovered incisor, a portion of the jaw being broken away on the under side. The condyle and coronoid process are wanting, and the sigmoid notch is also gone. On the under portion of the mandible the alveolar cavity of the incisor is broken into between the symphysis and the angular (?) process, disclosing the dark-brown enamel of the incisor. The angular process is about half an inch in length, directed obliquely inward and backward Its base extends antero-posteriorly an inch and a half. Its shape is that of a blunt rounded wedge, and its under surface is in a plane at right angles to the grinding surface of the molars. The four molars are all preserved perfectly. The first one, which rises a little more than half an inch in front, above the alveolar cavity, has four, obliquely transverse lamellæ, or flattened hollow plates, covered with enamel and cemented together, one after the other, by layers of *crusta petrosa*, which also seems to fill their interior. Within the alveolar cavity these plates, or sacks, at least in the fourth molar, are separate and free, and when this tooth is taken out their lower ends are open. The outer surfaces are finely striated perpendicularly, and crossed transversely by undulations of growth. The second and third molars have each three lamellæ, the first and last of which are obliquely transverse but parallel, while the second is more obliquely transverse and longer, nearly touching the interior angle of the third and the exterior angle of the first. The lamellæ all cross the mandible from within obliquely outward and forward. The second and third molars are of nearly the same size and shape, but they rise less above the alveolar cavity. They are sunk deep within the mandible, along the outside of the incisor. The enamel ridges on the grinding surfaces form a broad letter S. In the fourth molar the dentinal plates are three in number and more nearly parallel, and less oblique to the general direction of the grinding surface. These plates terminate on the upper surface of the incisor, which passes below, or along the inside of the bases of all of the molars. The symphysis of the mandible, where it united with the other ramus, is three inches long, there being a thickening of the bone and a downward process on the under side of the ramus where the incisor in use would most need a powerful fulcrum. The greatest diameter of the incisor, where broken, is one inch.

Its section is sub-triangular, the outer and lower surfaces being rounded, while the upper and inner surfaces are flat or slightly concave. The exterior curved surface is grooved longitudinally, with 18-20 grooves, which are about twice as wide as the ridges they separate. They are unequally distant, being more close on the lower side than on the outside. The inside and upper side are not thus grooved, but they show fine transverse waving undulations of growth, which also are sometimes visible crossing the grooves and ridges of the exterior surface. At the extremity, which seems to have run nearly to a point (now broken off) rather than to an edge, the enamel is worn away by use on the upper side about an inch from the end. There is a large duct or canal entering the ramus about an inch back of and above the fourth molar, which, passing the fourth molar without bifurcation, descends obliquely over the incisor outwardly, and passes below the third molar. The grinding surface of the molars is concave in the direction of its length, as in other specimens that have been described. Its length is three inches. Our specimen thus compares with others in the length of the grinding surface of the molars:

The Clyde specimen	2.7½	inches.
The Nashport specimen	2.8	"
The Memphis specimen	3.1	"
The Minneapolis specimen	3.0	"

Prof. A. J. Allen regards the Castoroides so constituting the type of a distinct and hitherto unrecognized family (*Castoroididæ*) and separates it entirely from the *Castoridæ*. In the same group he inclines to include the Amblyrhiza and Loxomylus, described by Prof. Cope, from the bone caverns of Anguilla Island, West Indies. This rodent, he says, "presents a singular combination of characters, allying it, on the one hand, to the beaver, and on the other, to the chinchillas and viscachas, and also to the muskrat, but which at the same time separate it widely from either group."

CASTOROIDES OH



E

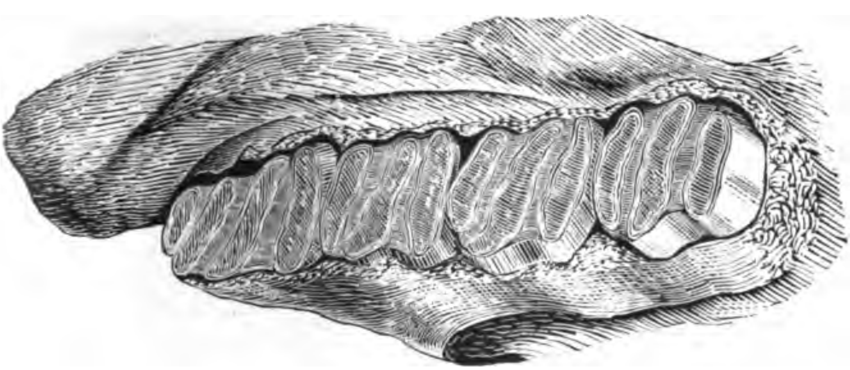
A

C

B

)HIOENSIS, Foster.

A. View of the fourth Molar from below.
B. Side view of the fourth Molar.
C. Section of the left Incisor.
D. Grinding surface of the Molars.
E. The left Ramus.



D

INDEX TO THE GEOLOGICAL REPORT.

ERRATA.

On page 12, 18th and 35th lines from the bottom, for *shine* read slime.
On page 19, 7th line from the bottom, for *pleocroic* read pleochroic.
On page 28, 10th line from the top, for *from* read four.
On page 134, 13th line from the top, after *takes* strike out the comma.
On page 136, 1st line, for *quartzytic* read quartzitic.
On page 143, 5th line from the top, for *pumiceusus* read pumiceus.
On page I43, 16th line from the top, for *memoralis* read nemoralis.
On page 174, 7th line from the top, for *this* read their.
On page 183, 8th line from the bottom, for *so* read as.

THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

THE NINTH ANNUAL REPORT,

FOR THE YEAR 1880.

N. H. WINCHELL,
STATE GEOLOGIST.

ST. PETER:
J. K. MOORE, STATE PRINTER.
1881.

Presented to

J. C. Russell

By N. H. WINCHELL,

State Geologist of Minnesota,

Minneapolis, Minn.

On behalf of the Regents of the University.

Contributions to the Museum and Library are solicited.

J.

NATURAL HISTORY SURVEY

OF

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1

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PUBLICATIONS OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY OF MINNESOTA.

I. ANNUAL REPORTS.

The First Annual Report of the Geological and Natural History Survey of Minnesota, for the year 1872. By N. H. Winchell. 8vo. 112 pp., with a colored geological map of the State. Published in the Regents' Report for 1872. Out of print.

The Second Annual Report on the Geological and Natural History Survey of the State, for the year 1873. By N. H. Winchell and S. F. Peckham. Regents' Report; 148 pp. 8vo.; with illustrations.

The Third Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1874. By N. H. Winchell. 41 pp. 8vo., with two county maps. Published in the Regents' Report for 1874.

The Fourth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1875. By N. H. Winchell, assisted by M. W. Harrington. 162 pp. 8vo.; with four county maps and a number of other illustrations. Also published in the Regents' Report for 1875.

The Fifth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1876. By N. H. Winchell; with Reports on Chemistry by S. F. Peckham, Ornithology by P. L. Hatch, Entomology by Allen Whitman, and on Fungi by A. E. Johnson: 8vo. 248 pp.; four colored maps and several other illustrations. Also published in the Regents' Report for 1876.

The Sixth Annual Report on the Geological and Natural History Survey, for the year 1877. By N. H. Winchell, with Reports on Chemical Analyses by Prof. Peckham, on Ornithology by P. L. Hatch, on Entomology by Allen Whitman, and on the Geology of Rice County by L. B. Sperry; three geoogical maps and several other illustrations. 226 pp. 8vo. Also published in the Regents' Report for 1877.

The Seventh Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1878. By N. H. Winchell, with a Field Report by C. W. Hall, chemical Analyses by S. F. Peckham, Ornithology by P. L. Hatch, a list of the Plants of the north shore of Lake Superior by B. Juni, and an Appendix by C. L. Herrick on the Microscopic Entomostraca of Minnesota, with twenty-one plates. 123 pp., 8vo. Also published in the Regents' Report for 1878.

The Eighth Annual Report on the Geological and Natural History Survey of Minnesota, for the year 1879. By N. H. Winchell, containing a statement of the methods of Microscopic Lithology, a discussion of the Cupriferous Series in Minnesota, descriptions of new species of brachiopods from the Trenton and Hudson River formations; the Geology of Central and Western Minnesota, by Warren Upham; report on the Lake Superior region by C. W. Hall; lists of Birds and of Plants from Lake Superior by Thomas S. Roberts; Chemical Analyses by S. F. Peckham; Report by P. L. Hatch; and four Appendixes. 187 pp. 8vo. One plate of Castoroides Ohioensis. Also in the Regents' Report for 1879 and '80.

II. MISCELLANEOUS PUBLICATIONS.

1. CIRCULAR No. 1. *A copy of the law ordering the survey, and a note asking the co-operation of citizens and others.* 1872.

2. PEAT FOR DOMESTIC FUEL. 1874. *Edited by S. F. Peckham.*

3. REPORT ON THE SALT SPRING LANDS DUE THE STATE OF MINNESOTA. *A history of all official transactions relating to them, and a statement of their amount and location.* 1874. *By N. H. Winchell.*

4. A CATALOGUE OF THE PLANTS OF MINNESOTA; *prepared in 1865 by Dr. I. A. Lapham, contributed to the Geological and Natural History Survey of Minnesota, and published by the State Horticultural Society in 1875.*

5. CIRCULAR No. 2. *Relating to Botany, and giving general directions for collecting information on the flora of the State.* 1876.

6. CIRCULAR No. 3. *The establishment and organization of the Museum.* 1877.

7. CIRCULAR No. 4. *Relating to duplicates in the Museum and to exchanges.* 1878.

8. THE BUILDING STONES, LIMES, CLAYS, CEMENTS, ROOFING, FLAGGING, AND PAVING STONES OF MINNESOTA. *A special report by N. H. Winchell.* 1880.

9. CIRCULAR No. 5. *To Builders and Quarrymen. Relating to the collection of two-inch cubes of building stones for physical tests of strength, and for chemical examination, and samples of clay and brick for the General Museum.* 1880.

10. CIRCULAR No. 6. *To owners of mills and unimproved water powers. Relating to the Hydrology and water-powers of Minnesota.* 1880.

ADDRESS.

THE UNIVERSITY OF MINNESOTA,
MINNEAPOLIS, Dec. 15, 1880.

To the President of the University:

DEAR SIR.—It gives me pleasure to present herewith the Ninth Annual Report on the progress of the Geological and Natural History Survey of the State, as required by the terms of the law creating the same. This annual report has been curtailed by the preparation of the first volumes of the final report, and some of the material which otherwise would find place here, is more properly reserved for incorporation in the final report.

Very respectfully, your obedient servant,

N. H. WINCHELL,

State Geologist and Curator of the General Museum.

REPORT.

I.

SUMMARY STATEMENT.

During the year, since the rendering of the last report, considerable time has been spent in laboratory, office and museum work. The crystalline rocks gathered during two seasons of field work in the northern part of the State, including the Cupriferous Series, the Huronian, and the light-colored granites presumed to belong to the Laurentian, have been provisionally arranged, labeled, registered and prepared for final examination. About 300 thin sections have been made for microscopic examination, and about one hundred, embracing the coast series along the north shore of Lake Superior, have been subjected to preliminary study.

In Palæontology considerable progress has been made in the determination of the *brachiopoda* of the Trenton and Hudson river formations, resulting in the identification of—

Seven species of *Lingula*, of which two are supposed to be new; one species of *Discina;* three species of *Crania*, of which one is new; fifteen species of *Orthis*, of which eight are probably new; three species of *Strophomena*, including one new species, and three of *Hemipronites*. Of these drawings have been made preparatory to final publication.

In the Museum important changes and improvements have been made. The central portion of the south room, devoted to geology and mineralogy, has been filled by the construction of a large upright case in which are to be placed the minerals, rocks and fossils of Minnesota, as fast as they are turned over for exhibiton by the

survey; and already a fair representation of them has been placed on the shelves; and the contents of all the cases have been inventoried. In the north room additions have been made to the stuffed mammals and birds, and to the fishes and invertebrates, from various sources, and especially from the United States Fish Commission.

At the spring meeting of the Board of Regents a communication from the St. Paul Chamber of Commerce, relating to the building stones, clays and limes of Minnesota, was referred to the State Geologist, with instructions to specially investigate and report as soon as possible on the same, respecting their quality, extent and accessibility. Such an investigation was at once begun, and is still going forward; but a preliminary report on the same, answering immediate demands, was made to the President of the Board of Regents some months ago, which by his direction has been printed as a separate and special document. At the same time a general circular was issued, addressed to builders and quarry-men, calling attention to the matter, and asking co-operation in procuring the necessary samples of rock for examination.

Another circular to *owners of Mills and unimproved Water-Powers*, was issued, intended to facilitate the collection of information on the hydrology and water-powers of the State, for the purpose of fully presenting this important branch of the internal resources of Minnesota in a creditable form, with tables and descriptions, in some part of the final report.

At the present time progress has been made on two volumes of a final report, and one of them will be offered to the Regents during the present winter. Suitable legislation should be had concerning its publication, by the biennial session of 1881.

In regard to the field-work of the survey, this has been prosecuted constantly during the working season by Mr. Warren Upham, who has been engaged in the southwestern portion of the State mainly, and has resulted in many valuable and very interesting facts relating to the drift deposits and the economical geology of that part of the State.

During the summer and autumn Mr. C. M. Terry has been engaged in an examination of the "Lake Region" in the north-central part of the State with special reference to the hydrology of the same and the distribution of forest trees, and later he has been engaged gathering information concerning the water-powers of the entire State, in accordance with the circular already men-

tioned. During the fore-part of the year he was engaged in the preparation of microscopic thin-sections, and on work connected with the Museum.

Some supplementary field-work has been done by the writer in the southern part of the State, with a view to settle some geological doubts respecting localities that had already been examined; and at the same time large additions were made to the collections of fossils from the Hudson River and Trenton formations.

Drawings have been made of maps and fossils in the laboratory of the survey, by Mr. C. L. Herrick, who has also acted as general laboratory and museum assistant.

Thanks are due to various individuals who have rendered aid in carrying forward the field work, or have presented specimens to the museum, or have given information desired, among whom it is just that the following should be mentioned: Mr. O. E. Garrison, of St. Cloud, who has contributed various manuscripts and maps concerning the geology of Stearns county and the upper Mississippi; Nathan Butler, of Minneapolis, who has given information of various interesting wells sunk in the northwestern part of the State; C. E. Whelpley and W. E. Swan, for information of the same character from artesian wells in the state; T. M. Young, for written accounts of glacial formations and morainic deposits in the upper portions of the Mississippi valley; Dr. D. F. Powell, B. A. Man, and others of Lanesboro, for relics and information concerning the pre-historic mounds lately opened near that city; and to the old Winnebago chief Winnosheik of Trempelean, Wisconsin, for an interesting tradition prevalent among the Winnebagoes concerning the mounds near Lanesboro; Mr. B. Juni, of New Ulm, and Thomas S. Roberts and H. V. Winchell, of Minneapolis for specimens for the zoological department of the museum; the United States Fish Commission, per Prof. S. F. Baird, for a set (No. 46) of the Atlantic coast and other fishes, and a set (No. 37) of invertebrates, prepared by the commission; Henry Mayhew, of Grand Marais, for specimens from the northern part of the state.

The survey is under obligations to the officers of the following railroad companies for free transportation for parties engaged in the field work during the year, viz: The St. Paul, Minneapolis & Manitoba, the St. Paul & Duluth, the Northern Pacific, the Minneapolis & St. Louis, the Winona & St. Peter.

II.

PRELIMINAY LIST OF ROCKS.

The following field and preliminary descriptions of the rock samples of the crystalline formations in the northern part of the state, with their accompanying localities, will not only furnish a running, brief commentary on the geology of the country, and show the progress of the field work there, but will serve also as a reference guide in the future investigation of their mineral and chemical characters, as well as in the final description of the geology of the region. The descriptions pertain mainly to the macroscopical characters of the rock, as they appear in the field, although most of the crystalline parts of the Cupriferous series have also been subjected to a preliminiary microscopic examination by means of polarized light in thin sections. In the field-notes made respecting these specimens, are full accounts, with sketches, showing their geological relationships, which are intended for the final report on that part of the State, when the field-work shall have been completed.

The specimens here described have been permanently numbered with a brush, with blue shellac and alcohol, to distinguish them from the serial numbers of the University Museum, which are in red shellac and alcohol ; and as they will always remain at the University for study and comparison, their value will be greatly enhanced if they receive only this incomplete serial description. To this list will be added other numbers, as the work progresses, and finally a set representing the typical rocks will be chosen for exchange with other museums.

The rock samples here numbered and described were collected in the field by the writer, in 1878, though sometimes accompanied and aided by other members of the survey The collections of Messrs Hall and Upham, of the crystalline rocks of the State, have not been tabulated nor examined sufficiently for report.

From Duluth to Pigeon River.

1. Nw¼ sec. 34, near Duluth, "Rice Point Granite" and its variations: gray, hard, appearing like massive labradorite, but also contains magnetite and augite, as essentials, with accidental quantities of epidote and a chloritic mineral that probably results from change.

1. A. From the same rock, but further N. E., being from the hill in the suburbs of Duluth, (intersection of 5th Avenue E. and 7th Street), taken because of a change there introduced in the formation.

1. B. Red rock, associated with No. 1, Duluth, consists essentally of orthoclase, hornblende and quartz.

1. C. Magnetited condition of No. 1, from the iron mine, Duluth.

1. D. Globular-weathering masses, appearing like a conglomerate, from No. 1, at a point about half way between the depot and Newson's quarry, Duluth.

1. E. Nodule from 1 D., same as No. 1.

2. A finer-grained rock, of the same general character as No. 1 A., and running in the form of a dyke, N. 30° W. and separating No. 1 A. from No. 3.

3. Compact, brown, or brownish red, heavy, with spots and specks of dark green. This spreads wider and is to be seen at other points back of Duluth, yet appears rather to be in patches, or in veins in other rock. At Newson's quarry a similar red rock penetrates the gray rock in seams, and occupies a larger area in the lower part of the quarry.*

4. A light colored, weathered, fine-grained rock, having specks of green and red, a cementing material for rounded masses of No. 1, showing sometimes a stratification dipping S. E. at an angle of perhaps 10 degrees: near the depot. This rock where stratified, and nearly free from masses of No. 1, has been quarried for rough walls.

4. A. Rock like No. 4, but coarser and more crystalline, that weathers out, in rounded masses, as if a conglomerate, from No. 4.

5. Occurs at the St. Paul & Duluth depot, about 20 rods from No. 4 A. It is a coarser form of No. 1, with more magnenite, and occasional grains of quartz, and some that in thin section seem to

*See the Annual Report for 1879, and the Proceedings of the American Association for the Advancement of Science for 1880 for a discussion of the relations of these rocks.

be orthoclase. This rock probably resulted from the complete fusion of the sedimentary beds and this mixture with the molten rock passing over and through them, as it contains some of the ingredients of both.

6. Dark green, heavy, homogeneous rock, coarsely crystalline, near the Bay in front of the Clark House, Duluth; immediately adjoining No. 43, and apparantly overlain by it; a wide dyke; west of Minnesota Point. Coarsely crystalline; consists essentially of a triclinic feldspar, augite, magnetite and chlorite (or viridite).

6. A. A dark-green rock finer in texture than No. 6. An extensive outcrop occurs beside the R. R. at Duluth, probable equivalent of 43.

6. B. Almost identical with 6 A, Duluth.

6. C. Fine, dark-green rock, quite amygdaloidal and porphyritic, Duluth, foot of Lake avenue. The amygdules are probably zeolitic, appearing radiated like laumontite. The red spots are stained by ferrite, and seem to be in the form of imperfect felsite.

7. Brownish-red rock, fine-grained, allied to the "red granite" of No. 1 B, and No. 3; belongs to the metamorphic series. Between 2d and 3d, Avenues, close to the water; underlies immediately No. 7 A: probably equivalent to No. 42, dip E. 18°.

7. A. Nearly black, amygdaloidal, metamorphic, a short distance from No. 7; has green mineral in cavities.

7. B. Brown, porous rock, filled with concretions and amygdules; wrought in the alley between 1st and Superior streets, and 4th and 5th avenues, East.

7. C. Coarse and dark-colored, separated from 7 A, by a joint; a dyke; equivalent of No. 47; roughly in line of bearing with No. 6.

7. BC. Contact rock between 7 B and 7 C.

7. D. From the dyke running toward Minnesota point; fine-grained; 6 ft. wide: has been reduced by quarrying.

8. Dark-colored, fine-grained, ground-mass carrying indistinct feldspar crystals porphyritically; separated near the wall of contact of No. 6.

8 A. Inclusion in No. 8; very fine-grained, gray rock: in thin section shows very fine crystals of a red feldspar, probably orthoclase, like the red feldspar in 8 B and 8 C; but mainly an amorphous felsitic mass with many inclusions.

8 B. Shows the flesh-red color of the feldspar crystals, which have the outward character of orthoclase, the groundmass being made up of changed feldspar, magnetite, haematite, chlorite and other minute grains; plainly a rock resulting from metamorphism of sedimentary beds.

8 C. From a dike in No. 8, or what has the aspect of a dike, but having the characters of No. 8, both apparent and microscopic.

9. Amygdaloidal, porphyritic, metamorphic.

10. Reddish amygdaloid, but has cavities lined with green crystals like epidote, lies over No. 11.

11. Finely porphyritic and amygdaloidal; dark green, with flesh-red feldspar crystals; east of the elevator.

11 A. From a vein running in 11; nearly epidotic; but sometimes also with a little quartz.

(No. 11 is mainly a massive homogeneous rock, but in som places finely jointed, so that under the weather it parts into numerous angular blocks. In it are veins (near its eastern extension) that seem to cause a greater abundance of the red feldspar crystals in the mass of rock adjoining on either side; and also in the veins themselves are sometimes, besides the green rock material, a white quartz, and a red quartzyte or jasper that has somewhat the appearance of the red feldspar crystals.)

11 B. From No. 11. Taken from a geodic cluster of various minerals mainly laumontite. This cluster is 14 feet long and 7 broad. There are others larger. No. 11 extends along the shore about 800 feet.

12. Finely jointed, amygdaloidal, red, metamorphic shale, containing various minerals in nodules and lining cavities, extending 49 paces along the shore, east of No. 11.

12 A. White nodule from No. 12.

13. Semi-crystalline, hardened red shale, with a feldspathic base, breaking conchoidally. On weathering it shows a laminated or slaty structure dipping E. 15°. In other places it is a lumpy amygdaloid with epidotic spots and veinings; 54 paces.

13 A. A more homogeneous layer of No. 13 overlying 13. It is slightly amygdaloidal and porphyritic; has a brown color and close tough texture.

13 B. Is a still more aluminous layer of No. 13; has a fragile almost fissile structure, and a green color. It is also amygdaloidal.

14. A dyke, breaking through No. 13, running W, 10° N.

15. From a dyke 15 feet wide, running N. 25° W. accompanied by some fine pyrite and some calcite.

15 A. From the west side of this dyke.

16. Modification of 13 and 13 A, extending, (next east of the brewery) 125 feet.

17. Metamorphosed brown sandrock, having a dip 43° E; slaty when weathered; extends 20 feet.

18. Firm, rusty-green rock, finely amygdaloidal and compact, in places appearing massive or with remote joints, and in others being weathered so as to crumble coarsely like a hardened laminated shale ; over this comes down a little creek, extends nearly into the bite of the next little bay, perhaps 300 feet, and before it is discontinued it becomes more broken and amygdaloidal, the change coming on imperceptibly. The dip at the last is 26° E.

18. A. From laminatonis of light-green mineral in No. 18, embracing calcite and a waxy, honey-yellow, garnet. In the calcite are needles of apatite and in the garnet is actinolite.

19. Rock similar to No. 13 A., fine-grained, light, reddish-brown rock, compact, scarcely amygdaloidal, weathering out in small, angular, blocks, as if it had been a shale. It has scattered green, amygdules and some red feldspar crystals. This suddenly replaces No. 18 on the east and extends about 200 feet.

19. A. From a large concretion of green mineral and calcite in No. 19.

20. A tougher condition of No. 19; harsh, porous and amygdaloidal. Embraces angular masses of No. 21, and extends about 40 feet.

20. A. Fine, shaly mass, embraced in No. 20.

21. Laminated, fine-grained, jointed, metamorphic shale, extends perhaps 15 feet, overlying No. 20.

22. A fine, green amygdaloid, very much like No. 18, overlying No. 21. This extends to the prominent dyke that rises about 12 ft. perpendicularly from the lake water, forming a small promontory —perhaps 300 feet. In this are crumbling spots of green rock containing hard lumps that are more silicious and crystalline. These lumps sometimes embrace chert, or light jasper, garnet and calcite.

23. Is from the dyke above mentioned; fine doleryte, basaltic, 15 feet wide, and has a direction N. S.

24. Reddish-brown sandrock, metamorphosed, but having thin laminations of green. It is also coarser than No. 17, dip. E. 35°—40°. Extends 50 feet.

25. Fragile, green amygdaloid, weathering and rusting to a brownish-red: seen about twenty feet to the east of No. 24, extending 100 feet. Then comes a rocky point near the fishery, which is—

26. Somewhat porphyritic, with flesh-red feldspar crystals, fine-grained, compact, weathering green, having seams of white quartz running at angles with each other.

27. From a dyke in No. 26 which exhibits a curious change of direction. It leaves the lake in a direction E. and W., but on ascending the rocky bluff it immediately changes to W. 15° S. It runs so about eight feet and shifts again to nearly W. The rock on the east side of the dyke is the same as No. 26, and extends to the point on which is a fishery. This is number

28. Heavy bedded, bluish-gray, becoming brownish, compact, fine-grained, very firm, much like the rock of No. 27, extending with evident bedded dip about 300 feet, passing under No. 29.

29. Crumbling, light-brown rock, containing much of the green mineral so common in these beds, in the veinings and interlaminations. Its upper portion is of a light-green color: a metamorphic shale, about 5 feet thick, dip 10° E.

30. Red or brown, metamorphic shale or sandstone, dipping 12½° N. 30° E.: varying from a brownish siliceous sandrock to one that is greenish and aluminous: unconformable bedding in this rock, probably shows different epochs separated by igneous outflow in other places; one part dips but little and the other dips E. 30° S., and in amount about 15 or 20 degrees. Extends 400 feet to Mallman's dyke.

31. Fine doleryte, from Mallman's dyke.

32. Hard, black, much like the rock of No. 31, but passes upwardly but few feet (3 or 4), gradually losing its firm and hard nature, as well as its color, and becoming in the bluff (which is 25 feet high) reddish brown, and breaking into angular blocks of a few inches under the action of the weather: taken near the water on the east side of a fault.

32. A. Taken from 32, near the top of of the bluff, a weathered modification of No. 32.

32. B. From green seams in No. 32.

33. About 60 feet east of No. 32 is another fault, and this number is from the amygdaloid on the east of this fault near the lake level; massive and roughly concretionary.

33 A. No. 33 is less amygdaloidal, more dense and firm in the upper part, with patches of fragile, closely jointed rock, like an indurated shale, from which this is taken.

33. B. Taken from the stratigraphical equivalent, in the extension of No. 33 A, showing a changed condition, but one which is gradual in the nature of the metamorphism, dip remaining easterly 13°—extent 30 feet.

34. Overlies No. 33 B, and is about 15 ft. thick, the two passing gradually into each other accross the bedding. This is a beautifully specked and spotted amygdaloid, some of the concretions being white, (⅛ to 1 in. across), some red (¼ to ⅛ in.) some green (¼ in.) and some with a red center enclosed in a green coating.

34. A. Concretions from 34.

35. Is about 12 ft. thick, a hard reddish, imperfect amygdaloid, with numerous natural seams, which serve as joints and cause it to part under the hammer in small pieces without showing a fresh fracture, just west of the mouth of Kin-i-chi-ga-quag creek (or Chester creek, as it is generally named now).

36. Like No. 18, is a hard gray, or brownish-gray, fine-grained, tough rock, very much like some igneous rock ; yet its extent, dip and position mark it a sedimentary rock, though it shows no sedimentary bedding: at the mouth of Kinichigaquag creek, on the west side.

36. A. Amygdaloidal porous condition of No. 36, having an abundant green material, from the upper portion of the bluff immediately west of the creek. This porous condition occurs in layers or belts in No. 36.

37. Rock immediately east of the creek, standing up like a dyke, compact, fine, basaltiform with some large geodic concretions ; continuing E. to a real dyke 18 feet wide ; pyritiferous, extending about 4 rods.

37. A. Calcite from a concretion in No. 37.

38. From the large dyke, 18 feet wide, running N. and S; greenish-black, finely crystalline: hangs to the E. 10°. The rock to the west of this dyke has assumed the character of a dyke-rock, very much; but this is not the case on the east side.

39. Rock next east of the above dyke; a breccia, with pyrites; extent 35 ft. dip E.

40. Hard firm beds next east; like the dyke-like beds on the west of the dyke; having at first a general dip E., but showing no regularity of dip; having rather contorted and confused bedding as

if the layers of the sedimentary strata had been plastic and molded on themselves. These characters on the face of the rock are brought out particularly on the smoothed and glaciated surfaces. Sometimes there appears also a rude concretiouary structure pervating the mass. The layers of contorted bedding are thin, or about ½ to 1 in. thick, and are sometimes perpendicular and transverse, and sometimes project irregularly above each other as they are hard or soft. On freshly broken surfaces this contorted bedding is evinced by bands of different color, some of them being greenish, and some brown, and some nearly black: but yet the whole is fine-grained, compact, and of a dark gray color, or bluish-gray color. This changes in its passage across a little bay, and becomes like No. 35, when it is suddenly replaced by number

41. A heavy-dark, green, or grayish-green, basaltiform rock; crystalline, neither porphyritic nor amygdaloidal, nor showing sedimentary structure. The columns tip about ten degrees from perpendicular toward the N. E.; varies from a texture like that of No. 7 C. to a finer grain, much like 43; an igneous overflow; adjoins No. 50 on the E.

42. Reddish-brown, metamorphic rock, rising above the clay like a "sheeps' back," four blocks north of the depot at Duluth; imperfectly porphyritic with fine crystals of flesh-red feldspar, and of a dark green mineral; probably the same as No. 7. There is a succession of such exposures on the hillslope running through Duluth northeastwardly.

42. A. A concretion from No. 42.

43. Compact, bluish, firm beds in outcrop on the hillslope back from the base of Minnesota Point, in front of the engine house. Width and form of this rock cannot be made out. Finely porphyritic with red feldspar in some places and is coarsely jointed. Apparently has a dip E. 30° N. Surface rounded over by glaciation; the equivalent of 6 A.

43. A. Porphyritic portion of 43.

44. From top of the hill at the head of 1st Avenue E., very fine-grained, black, like diabase.

44.[1] Hard, compact, fine-grained, from top of Kinichigaquag Falls; the extension of No. 43.

45. From a ravine, between No. 44 and No. 1 B, on the hill; brownish-red, fine-grained rock; a form of No. 3 and 1 B.

45.[1] Foot of Chester Creek Falls, similar to No. 44[1], but having a little scattered mottling of red, as of feldspar.

46. Sedimentary rock metamorphosed to red porphyry; from Brewery Creek, Duluth.

46.[1] From the Weller farm road, back of Duluth, south side of the hill, showing the contact between the "red granite" of No. 1 B., of the metamorphic series, and No. 1 of the igneous rocks.

47. From an outcrop of No. 7 C, on Superior st.

48. From 2nd st., cor. 4th Av. E., close-grained and firm, hard, bluish-gray to black, heavy, not visibly amygdaloidal, but finely porphyritic. This runs from in front of C. Markell's house, where it can be seen in outcrop, under the Hayes block. It is a large member, at least 150 feet thick, and falls in the unseen interval between Nos. 7 and 6 C.

49. Igneous rock, which seems to consist principally of Labradorite, augite and magnetite, with chlorite and ferrite as products of change; from behind the M. E. Church, between 2nd and 3rd streets, and 3rd and 4th avenues west. Hand to hand samples show no outward difference between this and No. 7 C, but there seems to be no way to stratigraghically correlate, or unite them, since 7 C cannot be a stratum running to No. 49, as it would go above Nos. 7 and 43, and others. Yet 49 appears to dip to No. 6, which is roughly in line with No. 7 C, though too far north.

50. Next east of the igneous rock of No. 41; an amygdaloidal breccia, with cavities, having in the main a reddish-brown color, but associated also with much green. This at first is so broken, and even columnar in some spots, with fine basaltiform columns, that it shows no dip, but further on, and just before reaching the next point, it has a marked dip E. 10° south, in amount about 18 degrees; extent about 150 feet.

51. From a point the next one beyond the breccia of No. 50; a brownish rock, resembling No. 7, much firmer than No. 50, and lies directly over it: disintegrates in small, angular pieces, according to innumerable weather-joints. Sometimes rises 12 feet perpendicularly from the water; extent about 200 feet.

52. Is produced by a gradual transition from No. 51, which it overlies; of three heavy beds, the lower hermetically united to No. 51, and passing into it. This is fine-grained, almost black, heavy and firm. This number has an interesting aspect. Each bed is finely and closely basaltiform, the basaltic columns being rather

layers running W. 10° N., and E. 10° S., from an inch to two inches in thickness, in a positon perpendicular to the bedding. They were doubtless produced by the baking effect of the next which comes on suddenly and in a position to immediately overlie 52.

53. Coarsely crystalline igneous rock, resembling Nos. 6 and 7 C; basaltiform; an overflow, or intercalated bed in the sedimentary rock; overlies No. 52.

53. A. Decomposed rock of No. 52, of a dark green color and velvety feel; mainly chloritic; sometimes lining cavities or coating joints; has an imperfect fracture like that across botryoidal hæmatite; hardness 2 or 2.5.

53. B. A part of No. 53, containing some flesh-red crystals, making it resemble No. 5; from the longest rocky point; N. W. ¼, Sec. 24, T. 50, R. 14.

54. From a small dyke 3½ feet wide, associated with others about 40 rods E. of 53 B., cutting No. 53 in a direction N. 5°E. Some of these dykes are narrower, and change their direction, and sometimes "pinch out" entirely. Where these dykes cut 53 it has so much of the flesh-red mineral that its prevailing color is brownish-red, and has been wrought for constructing the break-water at Duluth. In the bite of another bay near E. Duluth, S. E. ¼, Sec. 13, is another finely basaltic narrow dyke, 4 feet wide, running across No. 53, the columns of basaltic structure running directly across from side to side, perpendicularly to the walls. No. 53 has here a strong resemblance to No. 5, and runs under

55. Which is from a sedimentary member of the series broken, ciated and baked, dipping N. 60° E, in the bite of a little bay at E. Duluth, continuing ½ mile (by the coast), becoming more broken, and slightly amygdaloidal, at the last, till the appearance of another bed of igneous rock. No. 55 is reddish, angularly and finely jointed, sometimes a jaspery rock.

55 A. Small concretions or cavities lined with quartz in No. 55.

56. Ferrugnious, brecciated, fine-grained, siliceous, fragile, almost fissile; a condition of No. 55.

57. Dark and heavy rock from a dyke, cutting No. 56; dyke 4 ft. wide, running N. 5° E.

57 A. From another dyke like No. 57, but ten feet wide, a few feet further E.; consistsng of a lump of calcite associated with a green mineral which is probably some form of chlorite, or delessite, resembling the green mineral of No. 53 A, result of change from pyroxene or hornblende.

58. The red rock (No. 55) continues with slight changes, rising perpendicularly, sometimes 25 feet high, to and beyond the creek somewhat larger than Chester creek, and about 80 rods east of Tisher's farm house, where No. 58 appears a little west of the town line between ranges 13 and 14 on the lake shore. This is a compact brownish-red rock with crystals of flesh-red feldspar, 15 rods. At Tisher's creek the beds are conglomeritic, standing vertical, the adjoining portions being slightly granitized.

59. An amygdaloid similar to No. 34; small outcrop in the shingle of the beach, having an apparent dip W.

60. Reddish-brown, finely crystalline, frequently jointed, hardly amydaloidal or porphyritic; from a little rocky point rising from the water, abreast of No. 59, with a straggling line of strike, and a sharp firm outline that runs nearly north inshore, having an apparent dip N. From this point as the rock composing it bears inland, the shore becomes continuously rocky and high round the bay immediately west of London. Further east this rock becomes amygdaloidal in patches, and coarsely concretionary, and finally wholly amygdaloidal largely with white calcite. This rock further east where more finely broken furnishes

60 A. Dog-tooth crystals of calcite which occur in a finely jointed or brecciated condition of 60 which occurs suddenly, like a dyke, extending up and down across the face of the bluff. This breccia is about twenty feet wide, and the characters of 60 return on the east of it.

60 B. Amygdaloid just west of the breccia containing 60 A.

61. Numbers 60 and 60 B continue to within six rods of where the bluff in an angular massive projection overhangs the water, where a change occurs, showing a dip in definite characters. This dipping rock is harsh, granular, resembling a grit, thinly bedded, grayish, weathering reddish; similar to No. 30; dip 24° N. 60° E; two feet thick in one lot of thin beds; metamorphic.

62. Returns after No. 61; like No. 60, but bedded like No. 61; metamorphic.

63. Overhanging rock, which toward the east becomes brecciated; a fine purplish amygdaloid; metamorphic; overlain by

64. A pyritiferous, green rock, in a heavy bed three feet thick, which also shows calcite and fluor, and overlies

65. Containing large calcite nodules, with chalcopyrite; evenly bedded; many jointed, brownish-red, forming bluffs of 18–20 feet.

64. A. Calcite, fluorite, and bornite, from No. 64.

65. A. Calcite, &c., from No. 65.

66. A fine amygdaloid; a modification of, though probably overlying No. 65.

67. Confused, half-baked, pudding-stone-like rock, forming the point next west of the larger creek that comes through London; rather firm and of a reddish-brown color; amygdaloidal mainly; appearing as if a siliceous rock in masses had been embraced in it, and metamorphosed with it; also has lumps of shale; some of these weather dark-green and some purplish red, or a "fawn color," and some a spotted, dirty, light yellow; in it also are nests of calcite accompanied by fluorite. Across the point runs what has the form and manner of a dyke, 6 feet wide, and the above characters, particularly the calcite-fluor nests are found in it. This dyke is of the darker colors and runs N. 50° W, and is amygdaloid itself, as if of a different age from the others. It is perpendicularly bedded, the beds running in the direction of the dyke, but is less durable than the rock through which it passes. No. 67 continues for 35 or 40 rods, and is subjected to great upheaval and flexure.

67. A. Lump of calcite and fluor from the dyke (?) just described.

68. A modified condition of No. 67 where it has been upheaved and flexed; thin-bedded, red or pinkish, hard, with their interlaminations of a translucent mineral like that in Nos. 129 and 140. From near London. This translucent mineral seems to be adularia.

69. Harsh, rather fine-grained, crystalline brown rock, forming the point next east of the mouth of the creek, not more than 6 rods from it; by its position appparantly overlying the last; cut by a dyke, N. 5° E., 3 feet wide.

69. A. On east the of this dyke this rock immediately becomes coarsely amygdaloidal, with calcite and a dark red mineral that is not quite so frail as laumontite, nor so light colored, but resembles it. No. 69 returns, making the coast, cut by occasional dykes, or modified and interbedded with igneous rock, and extends half way to Lester river. Before reaching its termination it is cut by a dyke 6 feet wide which forms a jutting high point but few rods west of the east boundary of New London. This causes no apparent change in the formation; but at the next high rocky point the beds are contorted and bent in all directions, as if the overlying rocks had been thrust against and upon them with great violence.

70. The rock that overlies No. 69, perhaps the equivalent of 64, or of a bed like it. It is a firm heavy metamorphic conglomerate, and causes a prominent point or break in the direction of the shore line. This contains quartzyte pebbles, with calcite and pyrite in the interstices, dip E. 20° N.; on the W. of Lester river.

71. One of the beds of the sedimentary formation; overlying No. 70: fine-grained, greenish rock having a reddish color along its seams. This continues but 6 or 8 rods and disappears under the beach, and nothing appears again till at Lester river.

72. Brecciated granular sandrock, or quartzyte, of a light-brown, or reddish color, homogeneous and thinly bedded, (or was so), at the mouth of Lester (or Passabika) river. The amygdaloidal structure does not pervade the sandrock, but it pervades the cement, or rock that fills the angular openings between the pieces of the breccia.

72. A. Calcitic amygdaloid, the cementing material of 72.

73. Rock from the east side, at the mouth of Passabika river. Fine-grained, similar to No. 71, crystalline, non-amygdaloidal, of a dark gray color, becoming brown along some of the joints, and in some large areas; Extent 1½ miles, with a low line of exposure; runs under No. 74.

74. Red rock next east of No. 73, extending for some distance; rather coarsely granular, changed from the sedimentary beds; cut by a dyke 25 feet wide running N. 10° E: afterwards a breccia, followed by a rock like No. 71 again. This last shades through various modifications into an amygdaloid, and thus continues to a point where some mining has been done for copper S. E. ¼ Sec. 34. T 51 N. R 13 W.

75. Porous, almost spongy, with laumontitic amygdules; from No. 74. At this locality there has been an unusual disturbance of the beds, all of them being converted into a breccia, yet with enough of the original lamination preserved to show the direction of the strike and dip. The layers stand nearly vertical, or dip at a high angle to the north, with flexures, the strike being nearly east and west. Colors vary from a light flesh-color to a brownish-red. The latter color is amygdaloidal, the former is more apt to be brecciated merely, or evenly bedded, or to be spongy likethe samples taken.

76. Directly lying on No. 75; resembles No. 71; interbedded with No. 75; containing laumontite amygdules, and nodules of calcite and fluorite; having somewhat a trappous aspect; runs under—

77. Which is the rock wrought for copper; a coarse amygdaloid with laumontite and calcite, containing some copper.

78. Firm, brownish-red, crystalline, or sub-crystalline, like some other numbers, forms the bite of Crystal Bay, often bedded, much jointed, disintegrating and falling in large loose masses, weathering light red or pinkish; containing nests of calcite crystals, showing perfect, sometimes double, terminations; these nests are sometimes 18 inches across, but generally less than 10. The crystals are impacted in a fine red clay which, with the crystals, are included in the cavities; the clay is laminated, and may have been infiltrated from above.

78. A. Crystals from No. 78.

79. Finely crystalline, of a brownish color, and basaltiform in jointing; but with this rock, which presents many characters of interbedded traprock, are seen also evidently metamorphosed sedimentary rocks, sometimes amygdaloidal and sometimes close and compact, sometimes highly tilted (generally to the east or southeast), and sometimes nearly horizontal; sometimes also presenting a false cross stratification, or false bedding, like some sandrocks. Samples represent the prevailing variety of rock along the coast from No. 78 for a mile or more, the bluffs being generally low—3 to 10 feet—with great confusion. With the various scenes of disturbance, upheaval and contortion along here it is impossible, with the various metamorphic effects, and the mingling of true igneous rock, to trace consecutively any formation but a few rods.

80. Samples of prehnite and cupriferous prehnite from the shaft about one mile up French river.

81. Trappous rock, dark, somewhat amygdaloidal; amygdules dark, or of the color of the rock. This rock decomposes into rounded grains or amygdules, becoming lighter colored. This continues to form the bed and bluffs of the creek for ½ mile or more, when it begins to show light amygdules of laumontite, of which

82 is a sample, appearing much like No. 81, and is really only a variation of 81. The same rock (81) continues, with some variations, to the mine of the French River Mining Company, where the road from Duluth crosses the creek (sec. 18). At this mine the copper occurs native in the rock that seems to run in irregular veins and crevices in the rock No. 81, which has the appearance of being an igneous rock. The ore (No. 80) consists of a gray-colored radiated prehnite, in cavities and veins in No. 81.

83. Heavy gray rock with geodic cavities lined with prehnite, also having laumontite.

84. Highly amygdaloidal rock from 1½ miles up French River. (Hall.)

85. A coarse loose rock easily crumbling under the hammer; yellowish white concretions. (Hall.)

86. Fine, hard, crystalline rock with chalcedony (?) concretions about two miles up French River. (Hall.)

87. A fine dark rock with no bedded srructure, at three miles up French River. (Hall.)

88. SW ¼ Sec. 10, on the lake shore; from the round point which bounds Sucker Bay on the west. Rock similar to that at French River forms the coast for about ½ mile, having a low outcrop. It is gray, heavy, amygdaloidal, the amygdules being of nearly the same color as the body of the rock, but in some patches amygdaloidal with a flesh-red mineral, harder and darker than laumontite, as at points west of the creek crossing secs, 9 and 10, sometimes thinly bedded and disintegrating.

89. Just east of this creek the exposed rock becomes heavily bedded and darker. Norwood here calls it a dyke, but it seems to be rather one of the heavy massive beds of igneous overflow, similar to those of Agate Bay; non-amygdaloidal, rather fine-grained, but having large geodic concretions of calcite, with an interior of laumontite. The joints are lined with a mineral Norwood styled heulandite. See Nos. 515 and 516.

90. From the east point of Sucker Bay, a massive, heavy-bedded, dark rock, sloping up from the water's edge, similar to Nos. 1 and 49; continues to Knife River; also forms Knife Islands.

90. A. From a conspicuous white seam or vein in No. 90, which strings and splits out in ascending the face of the rock from the water; spongy and apparently siliceous, but too soft to be of quartz.

90. B. Concretions from No. 90.

91. Rock from the east side of Knife River, passing under the rock of the point (No. 90); with amygdules of white minerals, some of which appear to be quartz, but many of them are of an amorphous white mineral which on weathering is slippery, This white mineral is also harder in seams and in some of the amygdules. (Same as No. 641.)

91. A. Represents the harder amorphous white mineral, but closely mixed with the soft.

91. B. The soft white mineral which Dr. Owen named thalite, placed by Dana under saponite.

91. C. Is from a spongy mass from near the center of a large concretion in No. 91, at least 3 feet in diameter, the whole concretion being at least 6 feet through; this spongy mass is largely made up of laumontite, and in some places it is rusty. There are spots in this rock (No. 91) which show clear quartz crystals, forming the nuclei of the amygdules, especially where the concretions are about ¾ inch or an inch in diameter, with the amorphous white mineral surrounding them; crystallized in these concretions are also found calcite and laumontite. This passage from quartz (in the centre) through amorphous hard mineral (opal?) to saponite suggests a posible origin for agates; viz: the dissolution of saponite and its losing $A_2l\ O_3$ and MgO, leaving the SiO_2 to crystalize in the centre. This 91 B (thalite of Owen) makes the main material in the amygdules of the amygdaloid ½ mile, east of Knife River, and as they are soft and weather out, the rock easily disintegrates. It is found also in veins and seams and in angular crevices.

92. Laumontitic amygdules, from about half-way between Knife River and Agate Bay. The rock No. 91 becomes more and more charged with laumontite in passing toward the east. In patches, and in some of the irregular beds of the rock, which is tipped and twisted in opposite directions, but mainly dips toward the lake, this laumontite is so abundant that the rock easily weathers to pieces. It there also is thinner and more regularly bedded, and forms the re-entrant angles of the coast, the "points" being formed by the more firm heavy-bedded trappous-looking portions of the series; when near the water-line these soft patches cause purgatories. These two variations cause a jagged, though nearly straight, coast-line for three or four, or more, miles from Knife River, in some places the rock rising about 30 ft. perpendicularly from the water. This even-bedded rock, with much laumontite, seems to be that which Norwood styled "volcanic grit," and on the southern shore is styled "ash-beds" by the miners. The "dykes" which Norwood mentions must be the firmer, broad patches and bedded sheets of more trap-like rock which occur in connection with the

amygdaloids just mentioned. There is no regularity, however, in the occurrence of these places. While this laumontite increases in quantity the thalite disappears. With the laumontite is crystallized calcite so that nearly half of the white masses that blotch the bluffs is often calcite.

93. From the firm, heavy, trappous beds, non-laumontitic, occurring as above with No. 92. At the point at which the samples are obtained (Sec. 10, T. 52, R. 11), the trappean bed, 7 ft. thick forms the height of the bluff, within a narrow bay, but overlies a bed of six feet of very laumontitic amygdaloid, which is also brecciated; under that (9 ft. to the water) is a rock that has an outward resemblance to No. 91, but has less of thalite and more laumontite.

93. A. The lower rock, last mentioned, with green (chloritic?) amygdules.

Through section 11, where a number of creeks come in, the shore is made of red clay, with a stony beach. The last rock seen is a low exposure of No. 91.

The west coast of Agate Bay is made up of a number of alternations of agatiferous, heavy beds of igneous origin, rather fine-grained, and layers of soft laumontitic, thinly-bedded amygdaloid, styled volcanic grit by Norwood. For some distance after rounding the point the coast-line is made, as noted, by a sloping rock-surface that rises directly from the water, the waves washing over a broad surface. This is taken for an igneous rock, but occasionally, before it breaks up, on entering the bay further, the overlying bed of laumontitic layers may be seen slightly under the soil, and tree-roots, or forming a continuous line of outcrop. The dip slightly changes in rounding the west point of Agate Bay so that in passing along the beach, in either direction from the long smooth rock-beach, one steps on lower layers. Within the bay the dip is nearly east. On the point, where first exposed, the dip is nearly south. Further within the bay other beds of alternating trap and amygdaloid are found to enter the coast-line, there being no less than five alternations which are numbered from above, below as follows, in the samples collected. These beds vary from eight to fifteen feet thick.

94. Trap, from the top of the bluff. Agate Bay.
95. Amygdaloid, underlying No. 94.
96. Trap, underlying No. 95.
97. Amygdaloid, underlying No. 96.
98. Trap, underlying No. 97.

99. Amygdaloid, underlying No. 98.
100. Trap, underlying No. 99.
101. Amygdaloid, underlying No. 100.
102. Trap, underlying No. 101.
103. Agates, veinstones, geodes, &c, from the layers at Agate Bay.

The point between Agate and Burlington bays is made by a succession of seven layers of traprock, alternating with loose, sometimes brecciated, amygdaloidal layers, while five are seen in rounding the corresponding point on the west side of Agate Bay; the firmer beds forming sharp rocky points, and the amygdaloid occupying the inward angles. They are each 10-15 feet thick and dip eastwardly, as on the west of Agate Bay. These cannot be distinguished from those already enumerated on the west side of Agate Bay. Burlington Bay is structurally a repetition of Agate Bay, whether by the same beds or not is uncertain, but quite possible; the general dip of the beds being toward the lake, about both bays, particularly on the westerly sides where, by the operation of high seas and winds, the rocks have suffered greatest degredation. The eastern shores of these bays are mostly made of pebbles and debris, and are low; yet it seems as if the rocky substructure were the governing cause of their westerly slopes. Hence these bays are due to a sort of trough-like downward sweep of the layers of trap and amygdaloid, within the bays, and the points to a similar upward sweep, the greater rock exposure on their westerly coasts being due to the greater erosion on eastward facing shores. The eastern shore of Burlington Bay, and the point, are constructed in the same way of alternating layers of soft and hard rock, the whole more or less igneous or vesicular. Near the extremity of the point is a remarkable instance of a heavy trap bed supported on buttresses of softer amygdaloid which separate deep and dark purgatories to the number of thirteen. The trap bed, which lies like the superstructure of a bridge on piers, is about ten feet thick, and the whole rises 25 or thirty feet towards the west, but descends gradually to the lake level towards the east.

104. Seems to be what Norwood styled heulandite, from the igneous layer that lies along the lake level at the great bridge, below the amygdaloid.

The bay next east of Burlington Bay is also made up along its western coast of a succession of heavy, dark, igneous beds, alternating with soft amygdaloids, the number of the former being four or five.

105. Sec. 22, T. 53, R. 10. The point on the coast here just E. of Silver Cr. is high and rocky, with mixed dark heavy rock and amygdaloid, as if from a conglomerate, rising about thirty feet perpendicularly from the water, and particularly on the eastern side. Along Sec. 21 the coast is low and rocky, with trap and amygdaloid, dipping generally into the lake, but through Sec. 29 it is mainly a shingle beach. The hill on Sec. 15 is abruptly elevated, facing the lake, (See 639) and caused by mixed trap and amygdaloid. It rises perhaps 250 feet above the lake, and further back about 400 feet, the top being of heavy basaltic doleryte. The whole coast line of Sec. 15 is high and rocky with this number—alternating or mixed amygdaloid and trap, with purgatories in the former. Sec. 11 is mainly a sand beach, with no rock, or only a single low rocky point, ½ mile west of Encampment River. This sandy beach continues to the middle of the coast line that is in Sec. 12, when trap and amygdaloid return, extending about ten rods after which appears the next.

106. A heavy, coarsely-jointed, coarse-grained rock, of which Encampment Island is composed, a truly igneous rock, in which the augite (?) shows metalloidal surfaces resembling bronzite. This also contains what is taken provisionally for the *unindividualized magma*, as well as plagioclose, magnetite, apatite and delessite, (same as 638). This rock also has concretionary or geodic nests of light-colored mineral resembling quartz or chalcedony.

107. From the point directly opposite the island. It is heavy, dark-colored, massive, but basaltiform, overlying a red amygdaloid which lies on a rock like that of Two Harbors. This rock seems to be an extension of the rock of Encampment Island, and the equivalent of No. 639.

108. Heavy trap, showing small grains or films of native copper, from the high bluff at the mouth of Gooseberry river. (See Nos. 517 and 518).

109. Trap from the falls of the Gooseberry river. S. W. ¼ Sec. 22, T. 54.9

109. A. Thalite &c., Falls of the Gooseberry.

110. Reddish, finely-jointed, and crumbling into many small, angular pieces, that on the beach are firm, red, and abundantly strewn

of Gooseberry river. This rock, which is seen about on Sec. 12, T. 54.9, is like that at Crystal Bay, which furnishes the calcites. The for some miles west. even making the red beach at the mouth bluff here gradually rises from the level of the lake at its western end, with a dip (?) almost perpendicular, but toward the west. In passing along 20 rods it gets horizontal, and even runs the other way, at an angle of 25 degrees. The perpendicular bluff rises 40 feet in its horizontal parts, and where the dip becomes 20° E. it is somewhat higher, continuing altogether about 40 rods. (V. 520.)

Nearly opposite this bluff is a rocky trap island in which are numerous concretionary masses which themselves are mainly of the same rock, 3 and 4 feet in diameter, and also many nodules of quartz, some of them being a foot or more in diameter. They are geodic and sometimes amethystine or agate-like. This trap is finely amygdaloidal in some places, but generally heavy, compact, and dark-colored; the two characters being disseminated so as to be irregularly mixed, one surrounding the other as if in concretions, or as if one had been cemented in the other as a matrix. This rook can be traced in the shallow water, directly under the rock of No. 110, up to the foot of the bluff on the mainland. There are here strictly two small islands separated by a narrow shallow channel. The rock of these islands, and the beds of the coast west of the rock of No. 110, rise toward the west so as to form the high land and bluff at Gooseberry River from which was obtained No. 108.

111 A. Heavy compact trap. Sec. 7, T. 54, R. 8.

111 B. Amygdaloidal trap. Sec. 7, T. 54, R. 8.

These are from the west side of a little bay in Sec. 7, one showing 10 feet and the other 6 ft. They are both greenish. The strike is nearly northward and northeastward, but forms the coast-line for ¼ mile, No. 111 B, gradually rising to a thickness of nearly 15 feet, when it passes inland as the coast-line, made of shingle, sweeps more eastwardly toward the mouth of Splitrock River.

112. Dark basaltic trap, holding masses of No. 113, from Splitrock Point. (V. 524.)

112 A. Vein rock, and calcite and stilbite (?) from a vein in No. 112.

113. Feldspar rock, probably labradorite, from the masses included in dark trap at Splitrock Point.

The west side of Splitrock River, at its entrance to the lake, is low, but the east side, or northeasterly, is high, and formed of a basaltic bluff of rock like No. 112, which appears on the immediate coast at a short distance east of the river. It there embraces a large block of a whitish-looking rock, which at a distance appears to be granite, but which in reality is what has been described by Norwood as feldspar (No. 113), protruding through greenstone. This does stand up like a dyke, but is in reality older than the trap, and occurs generally further inland, forming hills several hundred feet high. This bluff rises sheer from the water 136 feet, and has basaltic dark trap on each side of it, the rock itself being massive. On the east of this high rock the trap shows included masses of the same rock, a fact which Norwood mentions, but yet speaks of the feldspar as a protruded mass of later date than the trap. On the west of the large feldspar mass is a vein in No. 112 eighteen inches wide, mostly now consisting of calcite (112 A), with coating of stilbite next the walls. (V. 522, 523, 524.)

114. Massive dark doleryte, occurring under the feldspar mass, and to the east of it. (Hall.)

115. Massive dark rock holding feldspar blocks. (Hall.)

115. A. Feldspar found in No. 115. (Hall.)

115. B. Vein running through the rock No. 115. (Hall.)

On east of Castle Danger (No. 113) there is a huge pudding stone of trap and feldspar for a short distance, and then under it is a short exposure of rock No. 110, just as the bay begins, which on the opposite side of the bay, east of Splitrock Point, appears again at the foot of a high bluff of feldspar rock which stands a little inland. Compare No.'s 522 and 523.

116. Rock on next bluff below the feldspar rock, and resembling rock 115. Point rises high, and is basaltic in structure; about half way between Splitrock Point and Two Harbor Bay. There is a conspicuous basaltiform layering on the east side of this point which slopes eastwardly.

117. The Two Harbor rock; a heavy fine-grained compact, brownish-black, bedded rock dipping eastwardly; in some places coarsely crystalline and reddish, containing small quartz geodes and crystals; these red parts sometimes cross the mass in the form of veins. In order of stratification this underlies the rock of No. 116, but is separated from it by Nos. 522 and 523, the stratigraphical equivalents of rock 520 and 110. It is one of the sedimentaries.

118. Crystalline igneous rock, of coarse texture, from the conical hill at the head of Two Harbor Bay.

The point that encloses the east side of Two Harbor Bay is a repetition of Castle Danger Point (or Splitrock Point), and is made up in the same way of a dark basaltic doleryte and blocks of gray feldspar; but here the rock No. 117 can be seen lying below No. 112. A little east of the perpendicular part of this bluff, yet before the detached masses of feldspar cease, can be seen a large smoothed surface of one of the feldspar blocks, uncovered by the falling off of the basaltic columns, presenting the characters of glaciation. The piece is 30 feet long and stands somewhat obliquely among the basaltic columns. On the main part of the striated surface the marks are large and wavy, and run obliquely upward at an angle of about 45°, as the surface slopes. The whole contour of the wall which is exposed over 20 feet of height, and ten or fifteen in width, is exactly that of the glaciated surfaces, being smoothed and marked transverse to the coarse jointing of the block, the face being toward the S. W. The striations and the whole smoothed surface run continuously directly under the basaltic columns of the trap that still stand in their places. If these be glacial marks, they furnish evidence of a post glacial, or an interglacial, igneous outflow. Still the marks can be accounted for, perhaps, by refering them to the slow action of the weather under the pressure of the slowly disintegrating basaltic trap. As the several columns became loose, but did not fall into the lake, their pressure, by gravitation, on a sloping hard surface, with alternate freezing and thawing, might so raise and lower them as to cause them to operate as slowly moving boulders frozen in a glacier.

119. At the next high point, about half a mile, the rock is reddish and basaltic, being like the red granite at Beaver Bay; with a couple of narrow dykes, closely resembling the red parts of No. 117. The dykes are compact and green. Immediately east of this, which rises about 50 feet, the latter, green trap, more coarsely grained, returns, in the form of a dyke at first, but soon as heavy beds of basalt, forming high shores, for ¾ mile; thence eastward to Beaver Bay the same rock forms the coast-line. This point (119) is composed of a sudden upheaval and metamorphism of both the rock of No. 110 and No. 117, the latter being basaltic and making the promontory point. It is red. The cause of the upheaval is seen immediately on the east of the point in the outburst of heavy drak trap which runs along and rises perpendicular about 30 feet —60 feet at the next point, and appears gray. This igneous rock

extends, in the form of a dyke, or overflow, toward the north and northeast, forming a range of lakeward sloping hills running back of Beaver Bay and supplies the iron-sand of Black Beach, three miles west of Beaver Bay. At Beaver Bay Point it embraces masses of feldspar rock again, and is suddenly replaced by a high and semi-basaltic promontory of red rock (No. 526.)

120. Feldspar rock, Beaver Bay. Resembles No. 1. (See 627.)

121. Coarsely crystalline rock from W. side of second small bay above Beaver Bay entrance. (Hall.)

122. A "greenstone;" columnar, and on inside and east side of same bay as No. 121. (Hall.)

123. Resembling No. 116 from bluff east of Castle Danger. (Hall.)

123. A. Block lying within No. 123 (Hall.) See 637.

124. Brownish rock forming the bluff at Beaver Bay entrance, on the west side (Hall); much jointed, semi-basaltic, supposed to be the equivalent of No. 119 (V. No. 526.)

124. A. Dyke-rock, within 124. (Hall.)

125. S. E. ¼ Sec. 2, T. 55, R. 8. Soft, reddish, amygdaloidal; explored for copper. Several test-holes and surface trenches have been dug on various sides of a conical hill made up of alternating layers of reddish brown firm rock (trap?) and soft amygdaloid, very much like the layers that form the hill west of Agate Bay. This amyglaloid is so soft when wet, and so fragile when dry that it can be crushed in the hands. It has a soapy feel, and a dull red color.

126. This rock, which furnishes by its disintegration the black sand at Black Beach, a few miles west of Beaver Bay, is found in places about ½ mile up the creek that enters the lake there, near the center of Sec. 22, T. 55, R. 8. It seems to consist of plagioclase (labradorite?) hypersthene and magnetite essentially, making the rock hyperyte, according to Dana's Mineralogy p. 210. The metalloidal surfaces of the crystals in this rock resemble those of the rock of Encampment Island.

127. From near the mouth of the river at Beaver Bay. A metamorphic rock presenting another condition of No. 124; frequently jointed, breaking so easily along predetermined planes that it falls, under the hammer, into small fragments, making it difficult to get a fresh fracture. In the main it is slaty, but its texture is tough and its exterior is angular. It is ashen-gray, but has, between the laminations thinner lighter laminations of appar-

ently siliceous matter; suddenly rises in a knob and disappears under the drift. In color, structure and texture this differs from any rock before seen on the shore. It rises about 60 feet and extends about 120 feet. Microscopically it appears to consist of quartz in fine grains, in a non-crystalline base. It extends more or less back from the mouth of the creek, toward the west, and appears slightly on the other side of the creek. (V. 528)

128. Feldspar crystals, weathered out of masses embraced in a crumbling doleryte, just north of the mouth of Beaver Creek. These feldspar masses lie within 15 feet of another outcrop of upheaved rock like No. 127, viz:

129. Similar to 127, but porphyritic with orthoclase, and translucent grains like adularia, thus resembling the rocks 68 and 140; an isolated buttress 55 feet wide and 25 feet high. This outcrop has no evenly laminated arrangement, but is frequently jointed and easily falls to pieces. It seems to be highly tilted in the form of a bed toward the south, and lies on the next, with an angle of 30 degrees. Occurs a short distance northeast of the mouth of Beaver Creek.

130. Finely siliceous, quartzyte. dark brown, a bed lying under No. 129, suddenly thrust upward, and presenting somewhat the outward form of a dyke.

131. Finely crystalline, of a bluish gray color or nearly black; from a point 6 rods further along (N. E.) in Beaver Bay, which embraces masses of feldspar; probably of the igneous series. This rock cannot here be said to embrace the feldspar, but the overlying trap is so mixed with feldspar pieces and is so nearly of the same color and rate of disintegration that they lie confusedly together; and in some cases pebbles of feldspar, somewhat changed, are in the surface of No. 131. (See 532.)

131. A. Stilbite incrustations from No. 131.

132. The green igneous rock that holds the feldspar masses, as in 131; generally basaltic. This is apparently from the same as No. 131, but at another point. (See 532.)

132. A. Red patches, &c., in No. 132; apparently consisting largely of stilbite, of a flesh-red color, and pierced by needles of light green mineral, which is probably actinolite. This occurs in nodules and patches, in veins and joints, going in different directions across the face of the rock.

133. The coast to the first island east of Beaver Bay is made up of the coarse doleryte 132, and feldspar rock. The island in the bay is of red rock, resembling the rock in the bluff of the west point of the bay, but approaching the rock of the high palisades. This number resembles the 2d island (large one). It is of the feldspar rock, or "Rice Point granite" entirely.

134. Red granite, generally basaltic in structure, but in places amygdaloidal and crumbling; coarse grained, from the 3d island from Beaver Bay. The 4th island appears to be of the same, but was not visited. Nearly opposite the last, but a little west, is a high bluff of brecciated or amygdaloidal reddish rock with one narrow E. and W. dyke. Another dyke forms an isolated ridge a few rods further east, rising a few feet above the water and running into the sand beach in the same direction.

135. A reddish-brown breccia, sometimes amydaloidal, with traces of carbonate of copper (?) and numerous calcite seamings. From the last mentioned dyke the coast becomes jagged, rocky and precipitous, with frequently jointed, reddish-brown rock, like the Two Harbor rock, which sometimes becomes grayish like the slaty quartzyte at Beaver Bay, and this becoming brecciated and amygdaloidal, with purgatories, for nearly a mile. Opposite this precipitous line of coast is the 5th island, and No. 135 is obtained along this high bluff (20–60 feet). It is evident along this high bluff that the hard gray rock of Beaver Bay is a variation simply of the reddish-brown losely jointed rock, since it shows in patches, and especially in proximity to the E. and W. dykes; and that the fine grained, reddish-brown rock, resembling some trap, as that of Two Harbor Bay, is altered, brecciated, and basaltified by the coarse-grained, igneous rock which is associated with it, the former being one of the sedimentay beds. Between Beaver Bay and the Great Palisades are numerous feldspar masses, in the coast series, and inland from the shore a very short distance is a range of low hills made up of feldspar, with traprock on their flanks.

136. Comes from opposite the 5th island. It is a crystalline rock, with much green mineral; varies from dark-brown to greenish and black. In close proximity to it, and at last forming the whole of the bluff mentioned, is a rock that is like No. 134. This

sometimes is bedded and slopes up from the water, at other times broken and basaltic, with high bluffs. Further along the rock No. 134 seems to be surrounded and embraced in masses in No. 136, very much as the "feldspar" is embraced in No. 112, but with much less contrast of color. This is due simply to variation in the same rock.

137. Samples shows the alternations of color between bright green and bright red in the rock No. 136. The green tint is caused by abundant chlorite. (?) The red is apparently that of a dark, flesh-red feldspar but also due sometimes to iron rust. Through them both are coarse crystals of what often appears to be amphibole. In the chlorite (?) are small quartz crystals with two perfect terminations. This is opposite the island, or about the center of Sec. 28, T. 56, R. 7, in a high bluff along the W. side of a little bay of which the east is of the same rock less high. The brightest colors and contrasts are near the water.

138. Rock from the tip-top of the Great Palisades, 315 feet above the lake; a hard, reddish-brown, fine-grained rock, with translucent rectangular crystals; sometimes porphyritic with a flesh-red feldspar.

139. So taken as to express the character of the rock of the bulk of the Palisades; of the same character as No. 138.

The Palisades begin after passing the little rock-bound bay of No. 137. Altitude of the perpendicular bluff near the mouth of the Palisade Creek, 125 feet; of the Palisades near the north line of Sec. 28, back from the bluff 145 feet, separated from the main Palisades by a slight depression. Highest point on the Palisades, 315 feet; highest perpendicular over the lake, 210 feet.

140. This number embraces a varied lithology, taken from the contorted concretionary and amygdaloidal parts that lie under the main basaltic portions of the Palisades. It is by the easier erosion of this that the face of the Palisade bluff gradually recedes inland. As they become unsupported, column after column of the bluff slides down perpendicularly and generally breaks into large blocks which remain and make a breakwater protecting the lower beds from the force of the waves and ice; but sometimes they remain standing partially erect and unbroken, after sliding down, leaning against the bluff. One can now be seen so standing, about 25 feet long. In this underlying portion there is apparent a degree of heat which was sufficient to fuse, or semi-fuse the material, and to allow of its being twisted and recurved so as to defy description.

Large, hardened masses or concretions occur in it; the whole of it contains the translucent crystals mentioned, as well as flesh-red feldspar. Some of it is red, some green, some brown, some dirty white or buff; some is laminated with thin laminae of the translucent mineral, and some is massive with a conchoidal fracture; the matrix of the crystals, and the parts between the translucent laminae are not crystalline but seem to have been perfectly molten once to allow for the crystals above; yet probably cooled rather suddenly; these laminated parts and other (brownish) streaked portions, appear to have been drawn out, at least the latter, in a streamed structure, containing less of the translucent grains and more quartz, which latter is clouded, under the microscope, with inclusions. This streaked structure is judged to be due to streaming from the occurrence of a few crystalline forms in it, which perhaps would not be the case if the structure were due to a preserved effect of original sedimentation.

141. Dark green igneous rock, like 112 which holds the feldspar masses. This *seems* to lie under the Palisades, as it comes in at once on the coast east of Palisade Creek, the rock of the Palisades suddenly disappearing with dip toward the lake; continues to near Baptism River, where a coarsely jointed, brecciated, grayish-red laminated and finely porphyritic fine rock comes in just before reaching the river, through which the river has cut a narrow passage or gate as it enters the lake.

142. From N. W. ¼ of N. E. ¼ Sec. 4, T. 56, R. 7, on Baptism River, 335 feet above Lake Superior; and about 30 rods above the fourth falls of the river. About ½ mile above this the river, and the country generally, undergoes a marked change, the former becoming slow and broad, and the latter level or undulating, without visible rock in either. The rocks here consist of alternations of trap, or basalt, with amygdaloid, similar to the layers of Agate Bay, dipping N. W. 20°. The lower beds of basalt form shelving points and bars across the river, but the upper ones are in the bluff on the west side, which is 35 or 50 feet high. There are at least 16 beds of basalt, more or less distinct, but they are not so thick as at Agate Bay. Here they are from 3 to 5 feet thick, and all dip in the same direction. The fourth fall is made by one of these, more coarsely crystalline than the others

143. The doleryte that forms the fourth fall of Baptism River. The fall embraces the whole river in one narrow cleft, and descends nearly perpendicular.

144. The river bed is then filled with large boulders of No. 143 for some distance, and all dip and strike are lost. The next that appears is a closely jointed dark rock, sometimes having red belts, and calcite seams, but mainly black. In this kind of rock is an abandoned exploration for copper, some distance above the fourth fall. There is also in the river bed along this place, large detached masses of feldspar rock.

145. The rock of the third fall, which is the same as the Palisade rock, as it apppears on the shore below Baptism River. It is reddish and compact with small translucent crystals. It is somewhat finely amygdaloidal, and weathers into rough slates, which are again cut by joints into lenticular pieces, that present their sharp corners as their neighbors fall out. These slates have a dip north. Indeed the rock No. 145, so far a it appears along the river here, has shown a dip northwardly, but only occasional exposures occur, generally low and water-covered. The rock here rises above the top of the falls about 30 feet, the whole height being 105 feet. Below this fall are large masses of feldspar rock loose. There is a series of amygdaloid and trap beds under the rock of the falls, that appear in the river about 25 rods below, dipping N. W., as the rock of the falls dips. The thickness and number of these underlying beds cannot be seen.

146. Forms the rock of the second fall, but the fall is in two parts. These are simply some of the layers of the trap that belong to the series, but are coarser and somewhat basaltiform. The blocks are coarser than they are generally between the second and third falls, though there is not much exposure along the river. This fall is about 30 feet. The samples come from the top of the first part of the fall. The beds are more compact in the lower portion of the fall; but all maintain the same dip, though in less degree.

About one-fourth mile below the second fall is a bluff along the right bank, rising about 80 feet, made up of layers of trap and amygdaloid, while the left bank is low, or gently ascending, and rises up as a trap layer rises in dip at an angle of 15°, the dip being toward the west, 15° N. This continues about ½ mile. The layer that forms the left bank, and slopes into the water is hard and fine-grained, but somewhat amygdaloidal in places with laumon tite.

147. Compact, but amygdaloidal with laumontite ¼ mile below the second falls of Baptism River; from the layer sloping into the river, as above described.

148. At the first fall, the dip changes from N. W. to S. or S. E. This number represents the lowest bed, over which all the other layers seem to fall in anticlinal. Although at the brink of the fall there is more or less basaltiform structure, there is no apparent dyke. In spots the dip is in different directions, between N. W. and S. E. or S. passing through W. as if by a quaquaversal toss the whole had been twisted. The bluffs are about 100 feet high below the fall.

149. About ½ mile below the 1st falls is a conglomerate outcrop on the east bank, dipping with a synclinal bend, 10° S. by 10° E. This is isolated from all other outcrops seen above, and the dip of all seen would cause this to overlie them if there be no other irregularity. The exposure runs about 12 rods along the shore, but its highest point is at the upper end where about 18 feet can be seen. The whole of it is red, and some of it is almost wholly free from pebbles, so as to be a red sandstone, but the greater portion of it is full of pebbles. Above this point a few rods some sand rock pieces can be seen in the river. Some of the pebbles are six inches across, but generally they are smaller.

150. Basaltic rock nearly in contact with No. 149, but so separated from it by debris of pebbles, etc., that its strategraphical relations to it cannot be seen. This is coarse doleryte.

151. A short distance further down, a rock appears which occupies the bed of the river at first, but gradually rises so as to form high bluffs. It is reddish-brown, porphyritic, compact, and has translucent crystals in form of rectangles as before mentioned, resembling the palisade rock.

152. Finely jointed, compact, basaltic, forming a precipitous, high shore on either side of the river, letting the river down to the lake level. This is dyke-like in character of rock, but confused and brecciated in outward aspect, forming irregular knobs and and escarpments. This is found after an interval of non-exposure in the river bed, after the last.

153. A contorted or brecciated, slaty, closely jointed and laminated, reddish-brown rock, forming the "gate" by which the river enters the lake, rising in bluffs suddenly at the lake shore and shutting in a bayou in the river. This is also porphyritic, and has translucent square crystals. There is an outcrop of the Beaver

Bay gray, slaty, quartzyte on the right bank below No. 151. Rock like No. 141 is seen first above the bayou, just below No. 152, in a short exposure like a dyke.

153. In the little bay first east of Baptism river. Beds of reddish-gray, slaty quartzyte, like those of No 127, cut by narrow, finely-jointed dykes, the upper portion being hardened and blackened so as to resemble the second rock appearing up Baptism river (153).

The little bay next west of the red point of rock (Palisade No. 2), is occupied by high, rocky bluffs, consisting of alternating amygdaloid and basalt layers, dipping N. W. The basalt beds are from 5 to 18 feet thick and the amygdaloid from almost nothing to 15 feet. The basalt beds make little points, and the amygdaloids form bays with purgatories. These beds run under the rock of the Palisade No. 2 (No. 154), which here rises perpendicularly in a high wall facing south.

154. Rock from the Palisades No. 2, a short distance east of the mouth of Baptism river; undistinguishable from that of the Great Palisades.

This Palisade rock continues easterly with irregular dip and bedding, and sometimes evident jointing, 18 to 30 feet high, for about half a mile from this point, where a layer of dark green doleryte of basaltic structure, twenty feet thick, is seen crossing the face of the bluff in a dip 30° E. of N. of 18°. The direction of the doleryte layer shows the prevailing direction of the dip of the rock in general, in which it is imbedded, though otherwise it would be only conjecturally to the northeast. Round the next little point come in alternations of trap and amygdaloid, as before described, dipping with the basalt last described. These continue to an exposure of conglomerate similar to that seen in Baptism river, dipping north at an angle of eight or ten degrees. The exposure of this conglomerate is 30 feet high.

155. Conglomerate. This has calcite nodules, and some laumontite. The stones are occasionally one foot in diameter. The higher beds come down to the beach with a low outcrop toward the west, but to the east the conglomerate is changed gradually into a reddish-brown or nearly black rock wholly metamorphosed and at a distance appearing firm and close-jointed like a fine dyke rock. Were it not for a continuance of the lines of stratification from the real conglomorate into this, it is hardly possible to recognize this as a conglomorate.

4

155 A. The pebbles are changed and closely cemented in the metamorphic parts, and only appear as blotches of dark brown color. The whole takes more the aspect of a fine but firm breccia like others that have been seen. The cause of this hardening and changing of the conglomerate is a doleryte dyke 20 feet wide, immediately on the east, running a few degrees west of north. This, in connection with another but a few feet distant, seen after passing the little point, seems to have caused a fault, so that the conglomerate is not seen beyond them. A bold short point of rock, like the palisade rock, next comes in, but it seems to be cut off by an immense dyke that runs behind it, and perhaps is the main dyke, the former being branches. This is 75 or 80 feet wide. Then follow successive layers of trap and amygdaloid, with a high dip about north, repeating the phenomena already noted. The dip here is about 40° N. 10° E. This makes a most beautiful nest of pinnacles and purgatories in quick succession, as the basalt beds project into the lake and break down by piecemeal, so as to leave sharp islands and belfries standing with the water on all sides. After this supervenes a heavy bedded coarse trap, crossed soon by a dyke ; and after this a pebbly beach for 40 rods, behind which seems to run the strike of the conglomerate, judging from the fragments on the shore.

156. Then comes a massive heavy rock, with a considerable ingredient of red, with jointed and contorted lamination, or in heavy massive beds. It has much amphibole and much magnetite. In other places it contains orthoclase and laumontite, the latter mineral causing an easy, natural disintegration. This is terminated eastwardly by a doleryte dyke 50 feet wide. It seems to be partly derived from the igneous rocks themselves, mixed in eruption with fused portions of the sedimentaries.

157. On the east of this dyke, where several veins seem to radiate inland, appears a light reddish hard rock, consisting largely of orthoclase and quartz, the former being imperfectly crystalline. with magnetite and red ochre in smaller quantities. This forms a high bluff for 10 rods, and is terminated by another dyke of 35 feet. Two other dykes also cross this red rock. (See No. 636.) Then, after a short pebbly beach, alternating beds of amygdaloid and basalt return, dipping S. W. This is near the western side of the broad shallow bay, on Sec. 30, T. 57, 6, where a hill rises near the shore. This bay is ½ mile or more across, has a pebbly beach except at one small point near its head, where a trap, coarse and rough, makes a small outcrop. The point on the east of this bay

is of trap and amygdaloid, in irregular alternation, rising 25 feet. It is long in the direction of the coast line, and precipitous. (See Nos. 630 and 631). Similar alternations of trap and amygdaloid (Nos. 631, 2, 3, 4, 5), with irregular bedding but nearly constant outcrop, run along for a mile, when the beach becomes stony and low, with occasional exposures of dark, rough and vesicular trap, to Little Marais. (V. No. 158). This is a short sandy and pebbly beach, crossed by the entrance of two little creeks, guarded from the N. E. winds by a hard trap rock layer that runs out in the lake like a breakwater, some distance; but toward the S. and S. W. it is perfectly exposed to the lake.

158. The rock first west of Little Marais; trap and amygdaloid, the latter having saponite and stilbite filling cavities, with some thomsonite.

158. A. Stilbite &c., from No. 158.

159. From the extreme east end of Little Marais bay; amygdaloid that is derived from conglomerate; contains amygdules of stilbite, mainly, but also saponite and calcite; having a general rusty-red color; underlies the next.

160. Forms the point that protects Little Marais from the east, and occupying, in the form of basaltic trap, the coast for two and a half miles further east, rising in some places about 100 feet, the conglomerate sometimes rising 50 feet above the lake, making a bold and dangerous strip of coast for small boats. The two interlock, and blend in stratification, and the conglomeratic characters, particularly, become confused, and even lost, apparently passing into amygdaloid. They dip toward the lake in the main, but there are spots where the dip is invisible. These extend to and beyond the Manitou river (See Nos. 628 and 629). This river makes a perpendicular plunge of about 20 feet just at the shore, but within a re-entrant angle and a narrow gorge. The river on entering the lake passes under an arch of confused and igneous conglomeritic rock; the latter characters being also mingled with amygdaloid, suggesting that perhaps other amygdaloids are changed conglomerates or other sedimentary rocks. This is a beautiful little niche in the coast line, the roar of the falls being as loud as that of the beach, and not more than 50 or 60 feet distant from each other. There is a narrow, crooked gorge also above the falls, but the river is wholly invisible, a sudden jog to the west cutting off all vision above, so that the water seems to come directly from the rock bluff. The lake bluff is about 65 feet high, and perpendicular from

the water. The overlying trap, somewhat basaltic, is about 30 feet thick. [V. 628.]

To the east of Manitou river the bluffs are not so precipitous. but the same rocks continue; and at the next river, where the water in a similar manner makes a short plunge (4 feet), directly from the rock into the lake, the bluffs are about half as high as at Manitou river. This is on the east of Pork Bay, which has a broad, sandy beach.

161. Trap from the shore at the town line between ranges 5 and 6 (on sec. 36), one of the layers associated with altered conglomerate in an amygdoloidal state; some having thalite and thomsonite. Some has what appears like prehnite (Lintonite?) and some calcite. These are not easily disseminated, but often are found in patches or clumps closely aggregated, the rest of the rock having less.

161. A. Brown, aluminous vein-rock in No. 161. These veins are from two to four inches wide.

161. B. Pebbles of thomsonite, from the top of No. 161.

162. Amygdoloid from the same place as No. 161.

From the last place to Sugar Loaf Point the coast is low, with much stony and gravelly beach, the points only being of rock; this rock is coarse dark trap.

163. From Sugar Loaf Point; a small point enclosing a little bay and harbor on the northwest side with a sandy beach, and having a conspicuous tuft of trees standing isolated from the low shore lying next west of it. The rock is rough trap consisting of two sorts and dipping south 10° east, at an angle of about 12 degrees. The upper part appears to be somewhat more uniform and basaltic, or massive, and of a greenish color, 18 feet thick. The lower is harder and has many concretions and amygdaloidal spots. These spots are in nests, the amygdules being of thomsonite and stilbite (?). There are perhaps of this 3 or 4 feet, but it is irregularly bedded, and contains pebbles as if conglomeritic. These pebbles and enclosed masses seem to be so thoroughly embraced in the rock that they were more likely to have been in the molten mass—semi-fused—than to have been of marine origin. The greenish color of the upper portion seems to come from the weathering of the firm trap. The upper portion also becomes globuliferous in disintegrating under the weather, exhibiting the characters that have been ascribed to melaphyre.

East of Sugar Loaf Point, to Two Islands, the coast is rocky most of the way, particularly in the western portions, with several short pebbly beaches. The rock is of the same sort as at the point, and along the beach are strewn white pebbles of thomsonite, with stilbite. The coarse basalt of the point rises again immediately on the east of the bay, disclosing purgatories below it in the amygdaloid, the bluff rising 25 feet, and being cut by canyon-like gorges, and crossed by two or three little streams before reaching Two Island river.

164. Trap rock, like No. 163, dipping toward the lake at an angle of about 12 degrees, between Sugar Loaf Point and Two Island river.

165. From the westerly of the Two Islands. The rock rises about 40 feet, basaltiform, on the west side, dipping S. E., conformably with the dip of the rock on the shore. The westerly is the larger island, 40 rods long, the other being about 20 feet high and 20 rods long. The rock is similar to that of No. 163.

The Two Island river, like many others, is closed during the summer months by a gravely spit that turns westerly from its point of starting from the shore, under the action of the wind and waves of the lake as opposed by the current of the river. The drift of the beach seems always to be toward the west, and these spits that shut up the streams are uniformly in that direction, the river being continued sometimes behind the spit for several rods before, by entering the gravel, it is finally lost altogether. The coast line is hardly broken by the river, especially in the existence of this spit, but the valley seems to be in the eroded place of one of the more amygdaloidal layers of the igneous formation that forms the coast line. There are several falls a short distance up this stream, as there are up all these streams, making the north shore more abundant in water-power than any other part of the State.

The rock of Two Island river continues to form the coast to Cross river, the shore ascending from the water with the slightly varying drift, from three to fifteen feet, but rarely having perpendicular walls.

At Temperance river the same beds are cut through by the river, and the underlying amygdaloid allows of the sudden recession of the lowest rock-barrier within the line of coast, so as to form a small rock-bound amphitheater, rising suddenly and perpendicularly from the lake-level on all sides, forming a good harbor for small boats. This is entered through a little niche in the rocky

coast, in quiet water. The water of the river descends by a short plunge over the next lower layer of trap-rock directly into the water on a level with Lake Superior. Above the fall is a narrow gorge, only visible on ascending the rocks, crooked and filled with cascades, through which the river rushes with a rapid current, throwing a white spray on all sides. This gorge exhibits some large potholes, some also worn and broken, thus showing how the river has eaten into the rock and excavated this gorge. There is no larger stream between this and the St. Louis.

Ascending the Temperance river the layers of the copper series can be seen constantly rising, the dip of the formation being greater than the descent of the river, so that by the time the falls are reached several hundred feet of thickness of beds have been passed over. They all have a general resemblance to themselves, being a trap like Nos. 163, 4, 5, but in places, or rather in beds, amygdaloidal, these beds coming in with a rough alternation, but not with continued regularity. They may have been partly sedimentary, but they show no outward signs of it, except, perhaps, this kind of stratification—which still may be due to successive overflows of lava. Indeed the amygdaloid beds seem to alternate in a manner as if a flow of lava became amygdaloided by degrees toward the upper surface, the denser portions passing upwardly gradually into the more open, but the open parts passing upwardly suddenly to compact, non-vesicular layers. There is also a marking on the uper surfaces of some of the amygdaloidal beds, which seems to show the effect of cooling from a molten condition. These marks or wrinkles are transverse to the direction of the dip. They are in a finer grained rock, though on the upper surface of the amygdaloidal layers, and seem to be of the same kind of rock, though redder, as the amygdaloid itself. They are seen at four different horizons, and overlie uniformly beds of a foot or a foot and a half up to three feet and a half of amygdaloidal trap, with which they are connected by slow changes into the same structure. They are themselves somewhat amygdaloidal, but with much finer and fewer amygdules. There is sometimes a thin belt, or interrupted stratum, of highly and coarsely vesicular and amygdaloidal rock immediately under the wrinkles, which causes the separation of sheets of the wrinkled finer rock from the rest of the bed. These wrinkled surfaces, which are transverse to the supposed flow of the molten rock toward the Lake Superior basin, may have been caused by the superficial cooling of a film of rock on the surface of the flowing lava. The lava continuing to flow—

toward the lake valley—the film was wrinkled by being obstructed by its own stiffness, as cream is wrinkled transversely on the edge of a pan as the milk runs out below. As the liquid below moved on, the crust somewhat stiffened, could not so freely move, but yet was not hard enough to maintain its position. By friction it was carried on more slowly, but wrinkled transverse to the force moving it. The crumpled layers are about an inch thick, but sometimes two or three are infolded upon each other, making a crumpled layer of three or four inches. They are much finer and denser in grain and structure than the beds on which they lie, and are of a redder color. The convex sides of the wrinkles are upward. The trap here is all of a dark color, as distinguished from the red trap and laumontitic amygdaloids, and overlies the red amygdaloids between here and Poplar river. The amygdules are calcite, stilbite, thomsonite, with chlorite in its various stages of change. Sometimes embraced in these wrinkled layers are lenticular areas or patches, ½ inch to 1½ inch thick, of a red grit, resembling the red sandrock with which these traps are associated; and within the amphitheater, near the water on the north side, is an irregular triangular patch of ferruginous, thinbedded shale, itself amygdaloidal, lying under a layer of dark trap and over the beds that show these wrinkled surfaces. Five layers of alternating trap and amygdaloid are visible between the lake and the first fall, somewhat less than ¼ mile up the river.

166. Heavy, dark trap, forming the gate to the amphitheater at Temperance river, from the top of the bluff, 22–25 feet.

167. Ochery, red, shaly beds of grit in a niche in the disturbed amygdaloid under the beds of No. 166, 0 to 3 feet; with fine argillaceous films.

168. Amygdaloid of calcite; same as the next, but taken higher in the beds.

169. Upper surface of an amygdaloid layer, rising like a dome near the water, exposing 3 feet.

170. Wrinkled upper surface of an amygdaloid layer, from near the mouth of the river.

171. From the lowest layer exposed at the falls, about one mile up Temperance river; outwardly a trap undistinguishable from all the rest at Temperance river. This fall is on N. W.¼ sec. 30 where a little creek joins the river from the northwest.

The gorge of this river, and the falls, taken with the cascades, the potholes and the rapid descent, are altogether a most remarkable combination of picturesque river erosion. They are in the

midst of inaccessible and wild scenery. The gorge is so narrow it can be stepped across, the only danger being to secure footing on the other side, for a failure would precipitate a man down a gorge from 50 to 100 feet into a foaming river. In one part of this gorge which is about 60 rods long, are several perpindicular falls of the water, some of them being into large potholes, from which the water whirls and plunges downward obliquely into .others. Some of the abandoned potholes are on the rock a hundred feet above the water, and some are even outside the river gorge, and show where the river has acted formerly.

172. About ¾ mile below the mouth of Temperance river; from a layer of trap that weathers green, is irregularly bedded and in spots is amygdaloidal. This is a little higher than No. 166, in the bedding, but at points further east, and particularly at a point about ⅛ mile east of Temperance river, seems to hold large globular masses, as if of boulders, and at other places seems to be conglomeritic in the same way. Nos. 167 and 168 become a thinly bedded amygdaloid running along the shore between No. 166 and No. 169.

172. A. Slickensided stilbite, from this.

173. N. E. Cor. Sec. 28, T. 59, 4. In a little stony bay facing N. E. This bay is partly shut in by a projecting trap point running N. E., from which this number is obtained. It is an amygdaloidal trap containing stilbite, thalite, calcite, with some laumontite in amygdules and in nests, and joints. The stilbite occupies the larger cavities, or lines them, the thalite being as filling to amygdules or in geodes of stilbite. The rock itself is roughly bedded, and dips toward the lake at an angle of about 10 degrees.

173 A. Stilbite, taken from No, 173.

173 B. Weathered stilbite (?) from the beach in the bay on Sec. 28, near No. 173.

174. At five miles from Temperance River (Sec. 12, R. 4. T. 59.) the bluffs rise from 20 to 40 feet, and are made up of trap and amygdaloid, sometimes having the globuliferous jointage noted near Temperance River; the amygdaloid also sometimes being conglomeritic, containing harder masses of more compact rock; still somewhat amygdaloidal; and a ferruginous sandstone which seems rather to fill veins and irregular cavities. There is much calcite and laumontite in this amygdaloid. The samples with this number are of the more compact rock in the amygdaloid, and of the sandstone. There are many deep purgatories and arched passages and buttressed porches along here. The globuliferous jointage

noted is not due to the existence of boulders in the mass, but to a natural separation of the bed along conchoidal or curving surfaces, as it prepares to disintegrate. These all dip toward the lake about 15 degrees.

175. At six miles (about) east of Temperance River (the coast all the way from that river being continuously rocky with the same as seen at Temp. R.), the conglomeritic beds appear on the coast. Here they are more distinctly conglomeritic than at other points. Some of them contain angular and somewhat rounded masses of different texture, though not of much different color or composition from the mass of the rock. Here there are also lumps of amygdaloid contained in a red sandrock, the amygdules being largely of calcite and laumontite: but the sandstone, which, however, is hardly gritty, but ferruginous and aluminous, makes up less than one-half of the mass. These beds (No. 175) are about six feet thick. They are overlain, in an oblique upward strike from the water, by a bed of trap undistinguishable from the trap that occurs frequently along here, and are underlain by the next.

176. A tough, thin-bedded rock, containing much iron, and having a red mineral (heulaudite ?) separating its frequent joints, so as to appear blood-red on approach, or spotted blood-red. Its general color is dark-brown or black, and it is seamed with calcite, heulaudite and laumontite, the second including the other two as between the walls of a vein, the veins being rarely more than ¼ inch in thickness. It is finely amygdaloidal with the same minerals; 22 feet thick; resembles the Two Harbor rock.

177. Is another bed of amygdaloid and sandstone, eight feet thick, underlying No. 176. (See No. 626).

178. Shows four feet, but beyond at another bluff, rises so as to show ten feet. It is a less amygdaloidal state of No. 177, and lies below No. 177. The last two numbers are got about fifty rods east of Nos. 175 and 176. There is an isolated pillar of No. 176 standing on a broad pedestal rising about twelve feet high, about forty feet from the shore.

Round the next little point, about 20 rods further, these beds are broken and confused, the dip changing to the southwest. There are here broken upward bends, or domes, of soft amygdaloid that encroach on No. 176 so as by weathering to make deep purgatories with buttresses of No. 176 separating them. After a short interval the beds go back again, and retain their usual dip toward the lake. (Compare No. 626).

179. Comes in below these amaygdaloids, at about a mile west of Poplar river; a greenish heavily bedded doleryte; rising about 10 feet and returning near the water, as the coast line crosses the strike of the beds. The coast between Temperance and Poplar rivers is very picturesque and interesting, but difficult for small boats. The trap and amygdaloids take a thousand fantastic shapes, as the line of the lake level cuts across the undulations of their bedding and change of dip. Sometimes the bridge of trap, as it runs down to the lake, is entirely eaten under, forming deep purgatories; or it sometimes breaks down, leaving islands of rock just off the line of coast. Sometimes island, bridge, and all are taken away, and the waves break on the base of a high bluff that often rises perpendicularly from the water, or is skirted by a little short pebbly beach, a rod or more inside the line of islands.

180. From the middle island at the mouth of Poplar river. Here the strike of a heavy layer of trap runs along the shore; but about six rods lakeward it exists as islands and a reef left by the waves, thus enclosing a small and imperfect harbor for small boats; contains thomsonite.

181. Underlies No. 180 and does not vary much from it, except in being more evenly and more thinly bedded; and in separating into closer joints, so as to disintegrate, leaving No. 180 to stand alone, and really causing its more rapid demolition. Nos. 180 and 181 form substantially one rock, and are both what has been styled trap along here. In weathering they become very rusty, when not under friction, and brick-red, crumbling in little red globules. These beds are 24 ft. thick.

182. Is directly under No. 181, and is a shaly, red, easily crumbling rock, apparently of not uniform thickness, but in one place, is about 8 ft. thick; on the east of Poplar river associated with a red conglomerate.

183. A highly amygddaloidal rock, exposed below No. 182, but ascending, at other places when exposed, so as to "pinch" out No. 182, and almost uniting with No. 181. This crumbles and gets brick-red on weathering on the beach. Nos. 182 and 183 seem to be the equivalents of Nos. 175, 176 and 177, but there is here no layer like No. 176.

184. A vein of breccia (?) about 18 or 20 inches wide crosses the face of a crumbling, greenish trap, running N. 40° E.; similar to a rock that seems to have been embraced in the vein; ⅛ mile east of Poplar river. This vein is nearly white and is made up of calcite, thomsonite and laumontite.

185. Laumontite and silbite; each associated with calcite, occur in large nests in the rock, of about the same beds as 183, at 3 miles east of Poplar river.

186. A little further east can be seen a very interesting instance of the manner of weathering of the trap beds. This is similar to what has been mentioned before, and styled globuliferous. The rock seems to decay to a considerable depth, and to assume a globular structure, the little globules being rough exteriorly, and generally about ½ inch across. This cannot be due wholly to any peculiarity of circumstance in exposure, since here we have an opportunity to see alternations of rough and globular weathering and of smooth weathering alternating in beds one above the other, the beds being otherwise outwardly undistinguishable. The rough and globular layers show these characters both near the water and also as they rise obliquely across the bluff, and the same is true of the smooth weathering layers. Samples show both.

187. An amygdaloid containing amygdules of zeolitic minerals, as stilbite and thomsonite, as well as delessite. Some of the crystalline nests are large, the thomsonite appearing agatelike. Some of the thomsonite is of the variety lintonite. This is at Eclipse Branch. [V. 625].

188. A greenish dolertye that weathers softer, slippery and smooth. It occurs suddenly at first, on a point running N. E. (Eclipse Beach), and enclosing a little bay, being a bed of overflow of igneous rock. It embraces corrugated surfaces like those seen at Temperance river, especially at points a little further east where it becomes closely associated with No. 187, which it overlies. It seems to embrace parts of No. 187, and then to take its place. The corrugated areas are small, the wrinkles curving, and being in various directions, sometimes like an inverted basin. (The equivalent to No. 623).

With various unimportant alterations between 187 and 188, or rock undistinguishable from them, but with a dip toward the lake of 8° to 15°, the coast continues rocky from the last point to Cariboo Point, (sometimes styled Black Point), and generally low, with only occasionally a bluff rising 10 or 15 feet. At Spruce river a high bluff rises along the right bank near the mouth.

189. Cariboo Point, S. W¼ Sec. 11, T. 60. R. 2. The rock of the point is represented by this number, and is of the same horizon as No. 188. On the east side of the point this rock is basaltic radiatingly, and shows a thickness of 8 to 12 feet. The basaltic columns gradually give way to a bedded stricture toward the

north. In some places it is fine-textured, especially near the top, and there shows the corrugations of surface that has been supposed to be old lava-crusts; but generally these are smoother than those seen at Temperance river. This dips toward the lake at an angle of about 10° and lies on the next.

190. A brownish-red sandstone, or shale, so fragile as to fall to pieces by handling; within the bay inclosed by Cariboo Point. This has a cross-lamination, and toward its junction with No. 189 is much less siliceous, and more aluminous for a thickness of about 12 feet. Its dip causes it to disappear, and its fragile character to become covered, within four rods of its first appearance, under No. 189. It re-appears slightly about 15 rods within the bay, having the same dip. Then for a little more than ¼ mile the coast is low and only pebbly. Beyond that, however, the shore shows the same rock again as on the west of Cariboo Point, though at first appearing more brecciated or conglomeritic. This sandstone layer) No. 190), is doubtless the same, or very nearly on the same horizon as some of the laumontitic amygdaloids so frequently seen further west, the conditions of metamorphism at this place not having been such as to convert it to amygdaloid. It is plain that not much heat accompanied the overflow of No. 189, as it seems not to have affected No. 190, the transition being abrupt from one to the other. (See after No. 293).

191. The rock which first appears on the east of Cariboo bay continues to Cascade river, forming a line of low coast. This number represents it at Cascade river. It there overlies the next.

192. A reddish-brown amygdaloidal, finer-grained rock than No. 191; forms a low outcrop on the right bank, near the mouth.

Trap-rock, like No. 191, occupies the coast, without any intermixture of amygdaloid, forming a low, dark, coast-line, to the point half way between Cascade river and the point on the west of Good Harbor Bay. At this midway point No. 191 is broken into, allowing the formation of a deep bay (Lover's Bay), while its direction near the lake level can be seen in a small island east of the point. Under No. 191, within this bay, are beds of less firm rocks which by the erosion of the lake cause the destruction of the overlaying beds, which, as the dip rises, make the top of the bluff at the head of the bay, rising 50 or 60 feet. This bed is greenish-black and contains thomsonite; sometimes basaltic and sometimes bedded, with a few spots of enclosed reddish amygdaloid. In other places the doleryte itself more compact and of a reddish-brown color in patches, as if brecciated or irregularly cooled, shows

lava-crusts and included angular and rounded masses. In these places the surfaces are firm, rough, and many-jointed. In other parts the dark green color returns, and the rock weathers smooth under friction, but in the weather only it crumbles. A lower bed of amygdaloidal trap, with purgatories, generally low, but rising near Terrace Point to 18 or 25 feet in height, extends from Lover's Bay to Good Harbor Bay. Near Terrace Point it presents much the character and confused composition as seen at Lover's Bay, being reddish-brown and brecciated, the top being more dark and firm, like a true doleryte, and containing thomsonite.

193. This is from the very point, which sharply encloses Good Harbor Bay; a green-weathering doleryte, containing thomsonite. (V. No. 535.) This dips conspicuously, and overlies a brown sandstone, or shale, which also dips toward the lake and runs 14 hundred feet along the shore.

194. Brown sandstone, from Good Harbor Bay; aluminous; by making measurement along the beach the outcrop is found to extend 1400 feet, with an average dip of 8½ degrees toward the lake; by trigonometrical calculation the thickness of the strata is ascertained to be 206.9 feet, as exposed, but the thickness must be considerably more, owing to the non-exposure of rock in an interval of nearly 1000 feet before the underlying firm beds appear in the beach further north. This is probably the equivalent of the sandrock at Cariboo Point, but may be another stratum. It is very frail and although sometimes a little slaty it will easily fall to pieces if taken in the hand.

195. Is a firm but porous amygdaloid, the pores and seams sometimes being quartz-filled, and iron coated. From the north side of the first little creek in Good Harbor Bay, underlying No. 194, but not immediately. Very soon the shore becomes rocky with a brown, rough rock, irregularly jointed and compact, appearing like that at Two Harbor Bay. This soon becomes irregularly mixed with the usual doleryte which extends to the second little creek, where there is a short pebbly beach. The same rocks soon return. The shore is rocky nearly all the way then to the point that encloses the bay in which Fall river empties.

196. From the rocky island off the point that encloses Good Harbor bay: a doleryte containing stilbite; similar to, and in the line of bearing of No. 193.

197. A reddish brown rock, closely jointed, and also breaking sharply with a conchoidal fracture; very rough exteriorly, i. e. with sharp projecting angles that tear the boots, but not porous or open; forms the point and coast line first east of Good Harbor bay, east of No. 195.

198. After passing a little point and a bay facing east, a green-weathering rock, finely jointed, and having an interior brown color, appears along the shore, and finally shows a basaltic structure and coarser grain near Fall river, where it stands out in the beach, and was illustrated in Norwood's report. Samples are from the basaltic parts. At some places the rock along here, west of Fall river, is slaty, and has a green color. Rock No. 198 extends to Grand Marais, generally showing its basaltic columns; but along the beach at one point having an amygdaloidal red rock below it.

199. The same as No. 198; from the basalt at Grand Marais, Contains plagioclase, diallage, magnetite, hæmatite, ferrite, apatite.

200. Samples of copper-bearing green-stone (gabbro), from N. W. ¼, Sec. 24, T. 61, R. 1 W., up Fall river. This heavy-bedded rock has slickensided seams, or thin filling between layers. These seams contain much chloritic mineral (delessite ?), some layers of it being ½ inch thick, with stilbite closely mixed with it, and also small quantities of calcite; the copper occurring in the massive, hard greenstone, or doleryte, in the form of thin spangling sheets once or twice the thickness of paper, or even ¼ inch thick. The sheets sometimes embrace three or four square inches in area. This location was wrought by Johnson & Maguire in the summer of 1876, and the face of the rock shows perpendicularly about 18 feet. It probably exists as a dyke.

200 A. Concretionary masses within No. 200, apparently having a large amount of diallage (?) with olivine, orthoclase and a white radiated zeolite, like prelinite. These concretions are perhaps produced by the inclusion of fragments of No. 201 in No. 200, when the latter was in a fluid state.

201. This, which is cut by No. 200, is the palisade rock, but has fewer of the translucent crystals of adularia than the Palisades themselves. It is properly styled a porphyritic, orthoclastic felsite. It is from the mine on Fall river.

202. Green, coarse doleryte, round the east point of Grand Marais; a low exposure in the coast line; with concretions or inclusions of a finer grain. This terminates rather abruptly on the

east, somewhat like a dyke when in contact with No. 203; but it is not basaltic, nor is the contact abrupt. Number 202 and 203 change colors gradually, and in fragments are mixed through a breccia of three or four feet wide.

203. Resembles No. 201, and is much like the Palisade rock. It furnishes pebbles for the beach which are strewn all along, making the beaches at Grand Marais. Dips 5 to 15 degrees toward the lake, or by the coincidence of the coast line it appears sometimes nearly horizontal. Sometimes it resembles the siliceous gray slates of Beaver Bay, No. 127. (v. 528). Under the microscope in a thin section this rock proves to be an orthoclastic red felsite. There are mono-clinic crystals of orthoclase in a translucent material, as well as sometimes large areas of orthoclase which show a uniform clearage and direction, as if belonging to one crystal in the general felsitic mass; but in general the felsitic mass is clouded simply by ferrite, and not distinctly crystallized; or in the thinner portions of the section it is porphyritic with sections of fine tabular crystals. These very generally darken when about parallel with either spider line, but not always.

203. A. From a vein of laumontite in No. 203.

204. 205. 206. } Transition rocks in the order numbered, between Nos. 202 and 203.

207. A doleryte like No. 202 which suddenly comes in crossing the beds of No. 203, forming a little point in the coast. This dyke is about 200 feet wide, and gives place to the beds of 203 again on the east.

These run perhaps 500 feet when another similar dyke crosses them. There are six such within a mile along here, and some are basaltiform obliquely. They run E. 15° S.

208. This rock occurs much like a dyke at first with perpendicular jointage, or basaltic structure in beds, but soon larger bedding crossing these, cut it, and cause the rock to all appear bedded. This is fine-grained and brown, and is about 25 rods from the last of the dykes already mentioned. This becomes a bedded rock, like similar beds seen before, having sometimes the appearance of the Two Harbor rock. It slopes toward the water. Just beyond the mouth of the third little creek (on the Lake Survey Chart) these beds become disturbed and brecciated and even tipped in the other direction (S. W.) and are crossed by a dyke of doleryte like No. 207, about 18 feet wide. Previous to this (further west) they show patches amygdaloidal; but just on the east of this dyke

there is much amygdaloid with laumontite. Just before reaching the mouth of the fourth creek another dyke like 207 crosses these beds running in the same direction as those before seen, and throwing up the firm heavy beds of No. 208 at a high angle. This dyke is basaltic perpendicular to these beds by being cooled by them. This last larger dyke is only exposed near the water, and its exact contact with No. 208 is invisible. It is exposed about fifty feet.

209. This is from still another similar dyke of doleryte cutting these beds, or interbedded in them ; the columns sloping obliquely inland. This is prominent and conspiciously basaltic perpendicularly to the highly tilted beds of No. 208. This dyke or bedded trap rock runs nearly E. and W., No. 208 dipping into the lake at an angle of about 45° in patches perhaps 20 rods, becoming less conspicuous toward the east, and at last disappears a few rods west of the mouth of the Devil's Track river under a low, red, pebbly beach, the pebbles being from No. 203, which here appears again. This beach continues for a mile or more, occasionally allowing the exposure of the rock in place, to the S. E. corner of Sec. 8, T. 61, R. 2, E., where appears in the midst of the shingle of the beach a different rock, viz:

210. This is in a low exposure. It is a firm, smooth-weathering rock, with a brown color and has an abundant green mineral; apparently one of the igneous beds.

211. Is from the same beds as No. 210, but from the point next west of Kimball's creek, known as Cow's Tongue Point. These beds here rise about 18 feet, shutting in a bay that faces east. This point is on S. E. ¼, Sec. 9, and the coast is rocky, with the same rock from No. 210 to this place.

212. After a short red-pebbly beach, in this bay, this number appears in low outcrop, and is the same redrock as No. 203, showing here nearly a horizontal bedding, running below No. 211.

213. From the extremity of Fish-hook Point, near the center of Sec. 16, T. 61, R. 3 E., eleven miles from Grand Marais.

314. Similar to No. 213. From Sec. 1, T. 61, R. 2 E., at the mouth of a little creek, west of No. 213.

315. Half a mile west of Fish-hook Point. These three numbers (213, 214, 215) all appear to be modified forms of No. 203. Fish-hook Point was formerly an island, but the lake has formed a continuous beach deposit running north, and enclosing triangularly a lagoon, as well as toward the S. W. The rock here resembles the rock No. 212 in mineral composition and aspect, and is probably closely associated with it, but its structure is different.

It is fissile, but generally only horizontally so, or with an obliqueness to the real bedding, which dips gently toward the lake. It is firm against the hammer and against the weather, but is filled with old cracks and joints that make it almost impossible to get a fresh break. It has a red color outwardly, like the rest near the water, except in the joints, which are blue-black with iron-shot (as Norwood describes such); but away from constant wave-action it is black. It is finely porphyritic, with stellar spangles of feldspar, and with isolated crystals which weather nearly white.

214. Is of similar rock, but more firm and crystalline, weathering red, and having some white amygdules. This has a low, inconspicuous outcrop, like others of No. 203, running along two or three hundred feet and dipping a little south of east. Number 215 is from a little point within the broad bay, nearly on the west side of the same section, where it rises about 6 feet, and, running along the beach three or four hundred feet, weathers red, like the rest, furnishing some of the beach pebbles of that color, In the lake opposite Nos. 214 and 215 can be seen a basaltic rock off shore, which does not appear on the beach and may be the extension of Nos. 210 and 211 forming Cow's Tongue Point.

216. Is a greenish-brown rock with curling internal structure, containing quartz and amethystine nests, from the westerly of the two little points west of Brule river, and before reaching either island, where a little stream enters the lake. It is a short outcrop rising about 5 feet in the midst of a red beach. This is an igneous rock; and the next point is of the same, also the little island off it, which is in the line of bearing.

217. In the midst of a red beach, extending from the last point, is an occasional exposure of this red rock, which within is brownish-red, fine-grained, and has the same purplish quartz (?), as noted in No. 216, in round amygdules, yet is plainly different from No. 216. It belongs to the modified sedimentaries of the kind like the Good Harbor rock. This is a conspicuous outcrop within the bay between two streams. The strike of the trap (No. 216), can be seen under the water of the bay

218. The rock of the point, near the Brule river, off which lie the principal islands. This is a brown, conchidally fracturing rock, fine-grained or crypto-crystalline, with small quartz-lined geodes, weathering rough-angular, and black when not under friction. Back from the line of friction, on the beach, old weathered surfaces are brick-red. This is very similar to No. 217.

219. A little beyond the last locality, and just as the rock dis-

appears again, it suddenly becomes slaty or closely-jointed and laminated, dipping S. 10° E., and more enduring. In this condition it forms some of the islands near the beach, and also rises 50 or more feet near the coast back from the water. This is fine-grained and nearly black, hard and tough. The rock of the main island, further out, containing a few stunted trees, is more like No. 218.

These beds seem to have been disturbed by some upheaval, and appear in all respects like those of No. 208, though not so conspicuously exposed. The doleryte dyke that might here be supposed on the north of this disturbance cannot be seen. The point at the north of the little stream west of the Brule, and the little island there, are of the same rock as the last.

220. Between these islands and the mouth of the Brule at a little dull point is a bluish-gray rock, weathering green, fine-grained and hard. The outcrop is rather closely jointed and in some spots it is reddish brown. This rises about 6 feet, but only runs 5 or 6 rods. The beach to the west of this is mainly of a red color, but has blue pebbles also from this rock. At this place the blue and red are about equally common, but the red gradually disappear in going east. (V. 539).

221. A short distance east of the Brule (perhaps 20 rods) is a coarser rock resembling gabbro, which is heavy and crystalline. This is not certainly a dyke, but it may be, its form and extent not being visible. This rock makes a fine thin-section, showing coarse crystals of plagioclase and diallage, with magnetite. The diallage frequently shows a fine striation of four or five belts, crossing the body of a grain, generally near the center, having color like striated feldspar. But these striæ are always in a single group. The halves of the grain have certainly different axes of elasticity, darkening at different places; hence it appears twined like plagioclase. Similar striation appears in other samples of rock containing diallage, and might be attributed to a grain of plagioclase lying under and showing through.

222. The last seems to overlie, or to pass into this. This weathers into a green color, but sparkles all over with what at first appears like mica, but in other respects it is like the last, becoming coarsely laminated when weathered. A little further east these two rocks (221 and 222) can be seen in a bluff rising about 15 feet, the latter being under the former. This rock continues, with increase of the characters of No. 221, and forms two or three little points within a mile east of the Brule, rising sometimes 15 or 25

feet. The intervening bays are occupied by large rounded boulders of the same, with little rock exposure in them, or they are pebbly.

223. The rock of the last continues to the high, round point 4 miles east of the Brule, and then becomes basaltic on the side facing Sickle Bay, rising about 30 feet perpendicular from the water; the intervening coast being low, sometimes exhibiting the coarse dark beds of this rock, but not becoming basaltic. (V. No. 540).

224. Horseshoe Bay has a similar basaltic coast line on the west side, rising about 60 feet. West of it are short stony beaches, the strike of the exposed rock being a little further back. Double Bay, next east of Horseshoe Bay, has a rocky point, dividing it into two parts, and this rock is from this point. The western half of this bay is without rock on the beach, but the hills back rise several hundred feet, having the same rock as the last. This is a fine-grained, metamorphic, brown rock, which is somewhat basaltic like trap, and also rudely bedded.

225. On the most easterly point of Double Bay is a crystalline rock which seems to embrace the minerals derived from the sedimentaries mingled with igneous rock material, all coarsely crystalline. (V. No. 5).

226. Is from an isolated dyke-like exposure on the beach in the next shallow bay. It is a brown or reddish-brown compact rock, firmly prophyritic, closely jointed and basaltic, like No. 203.

227. Along the west side of the ridge, or spur (No. 226), is a narrow bed or dyke of fine, blue-grey rock, sparingly porphyritic with red feldspar, less enduring than the rock of No. 226. It is nearly invisible, It is narrow, and its line of bearing becomes confused, or blends with the rock of No. 226, being perhaps a modified form only of No. 226, due to different influence in upheaval, or to unseen contact with the accompanying igneous rock. This outcrop is between the 1st and 2d creeks in this broad bay.

On the little point between the 2d and 3d creeks is a low exposure of rock that resembles No. 223, mainly broken into boulders. Also a small isolated outcrop is just east of the 3d creek, otherwise this bay has a pebbly beach. But the broad point that separates it from Cannon Ball Bay, (similar to Horseshoe Bay) has a low, rocky beach of the same rock as the last mentioned, viz:

228. A heavy bedded coarse-grained doleryte. (V. No. 540). The east side of this bay is made of the same rock, also the east point, also the island east of it; the coast being rocky and low, or

rising from six to ten feet, basaltic. The next island, and the coast along, especially the points of the coast, are of the same. It rises into basaltic coarse beds in a sharp point on the west side of Red-rock Bay, succeeded suddenly by a red pebbly beach within the bay, strongly contrasting with the dark green or black color which it suddenly replaces, (230).

229. Doleryte like 228; from Red-rock Bay, west of the red rock, outcropping in the midst of a red pebbly beach; runs under the E. Palisades.

230. Red rock from Red-rock Bay. This resembles, or is exactly the same as the Palisade rock. It is porphyritic with flesh-red feldspar, and with translucent crystals that at a glance appear like quartz, but are seen to be quadrangular in section, sometimes square, and to have a perfect cleavage. The manner of exposure is considerably like that of No. 226 in a little bay west of this place. This rock has an imperfectly and finely basaltic structure, the joints being 2-4 inches apart. The relations of the doleryte to this cannot be distinctly seen, but that rock can be seen to the west in the beach, and probably passes below this. This is the rock known as the eastern Palisades. (V. No. 620).

231. From a dyke of basaltic doleryte a short distance east of the mouth of the Redrock creek. This dyke runs E. and W., and is horizontally columnar. It cuts the rock of No. 230, and varies from 50 to 60 feet wide. It is a fine-grained, blue-black, and weathers greenish. It embraces patches of the red rock.

At Red Point, which encloses a deep little bay facing east, and which is high and rocky, with No. 230, another dyke of the same kind as No. 231 crosses No. 230. It is about 25 feet wide. No. 230 dips into the lake here at an angle of 6 to 10 degrees. It is suddenly discontinued in the bite of this bay, the bluff running inland about 20 feet high, the beach being of red pebbles. Just east of this bay are two or three other dykes of the same kind, and several islands formed by them, also some sharp, narrow points.

232. The first rock that appears in the pebbly beach east of the rock of Red Point, near a dyke; a brownish-red metamorphic compact rock, sometimes with amygdules of a white mineral, coated with green; apparently underlies No. 230; resembles some of the compact brown rocks seen at Duluth and at many intermediate points.

233. From a dyke, near No. 232, 21 feet wide, horizontally columnar, running N. 15° E. and projecting into the bay 75 to 90 feet, of a blue-black color.

234. From a dyke 18 feet wide running E. and W. "hading" a little to the south, cross-columnar, cotemporary and blending with the dyke 233, the structure of the two running together; of a brownish-black color. This rock is like a melaphyre, but No. 233 is not.

235. A rock similar to No. 232, cut by the dykes, having a slaty structure without any dykes; forms the beach next north of the dyke No. 234 which is out in the water.

236. From a dyke 21 feet wide; a fine-grained, black basalt, running out into the lake about 250 feet, but often in the form of islands that occur a little out of line. The basaltic structure of this is very irregular. In some places it is fine and in others it is coarse; runs No. 15° W., being intersected by the dyke No. 234, apparently in the same manner as No. 233.

237. Is from a curious isolated mound of metamorphic firm rock, standing between the beach and the lake, a short distance east of the dyke No. 236. It is curvingly bedded and laminated; rises 18 feet and extends 18 feet on the beach, shaped like a hay-stack. It has a reddish-brown color. Its manner of occurrence is like that of the rock No. 226.

238. Is from a curving, slaty condition of the same rock, rising 10 feet; there is much confusion and twisting of the slaty sedimentary beds, the whole formation being broken up. Nos. 237 and 238 continue east about half a mile, and gradually become more dense, or non-slaty, yet fissile hard, and angular, crossed by several smaller dykes running E. and W., or S. E. and N. W.

239. Shows the condition of the same beds in process of this change. Here also are slaty spots, also compact firm spots, but instead of red the general color is brown, weathering faint-red in the old joints when freshly separated.

240. A reddish-brown, fine-grained rock, breaking conchoidally, but a further metamorphic condition of No. 235.

241. Still further changed, becoming black, and almost undistinguishable from fine basalt.

242. Next appears a dyke about 100 feet wide, cutting these beds, running nearly E. and W. This seems to have spread largely, at least in its effects, on either side, and the adjoining rock appears like basalt, but still seems to be only a changed condition of No. 235.

Nos. 232 and 235 and their modifications, run under No. 230. There are spots in No. 235 that appear like the aluminous mud-spots seen in No. 194.

The alternating phases of Nos. 239, 240 and 241 continue, with occasional dykes, or overflows of rock like No. 242 to Deronda Bay, appearing like the Two Harbor rock.

243. From the west point of Deronda Bay: a fine-grained, hard, nearly black homogeneous rock, of doubtful origin; probably one of the forms of the rock 235, &c. It is rather bedded, but not basaltic, and lies on an amygdaloid, viz:

244. A reddish-brown amygdaloid, with green amygdules irregularly passing into

245. Which is of the same color but has nests of a lighter mineral, and is mainly a non-amygdaloidal rock. Just west of the west point of Deronda Bay is an island of basalt, near the shore, mainly made up of rock like No. 242, in an arched position, the waves having eaten under the arch into the softer beds producing a natural bridge. The head of Deronda Bay has a pebbly beach, but the east side is rocky, with a dyke that "hades" to the south and is thirty feet wide, running nearly east and west, and cutting rock like 244 and 245 (or 246 and 247), there weathering out as purgatories, and lying nearly horizontal.

246. About ¾ mile east of Deronda Bay at the mouth of another little creek is a bluff of rock made up of Nos. 246 and 247, but running but a short distance. Number 246 is soft and green with considerable procholorite. (?) The lower ten feet of this are somewhat amygdaloidal with calcite and quartz, coated with green, but the upper ten feet are massive or heavily bedded, but breaking easily into sheets; overlies the next.

247. Amygdaloid; rock like the last but having a more amygdaloidal character.

246. A. Calcite, saccharoidal and flesh-colored from 246. These beds dip S. about 12 degrees. East of Deronda Bay the second little sharp point is caused by rock like No. 246 dipping S. rising 10 feet. The third little point, which occurs after a pebbly beach of half a mile, is produced by a wide doleryte dyke running E. 10° S.

248. Is from this dyke, which has an indefinite width, at least 200 feet. This rock is porphyritic, hard and massive. On the north side its contact is a fine basalt, and the adjoining rock is an amygdaloid, but only about six feet of the amygdaloid is here. It lies along the dyke as if it belonged to it.

249. Amygdaloid adjoining No. 248.

250. The west point enclosing Grand Portage Bay is low, but

has a rocky beach consisting of alternate layers of basalt and amygdaloid rising but little above the water.

251. Underlying No. 250; an amygdaloid of a greenish color. These beds (Nos. 250 and 251) dip south at a low angle and do not extend into the bay. They apparently form the coast line between Grand Portage Bay and Deronda Bay, there being but little outcrop with a low shore between these places. The west side of Grand Portage Bay shows no rock. It is low, the timber growing nearly down to the water.

252. Slate from the west side of the village of Grand Portage. The outcrop is near the water and along the beach, rising also into hills a short distance inland. It is cut by a prominent dyke of dolerytе, 39 feet wide, running E. 15° S. Some of it seems to be suitable for roofing, but some is too hard and brittle. It also has septaria several feet wide, round which the slates are disturbed and warped. They dip S. 5 degrees. They are not due to a superinduced slaty clearage, but are caused by the slatiness of the sedimentation with which they are coincident.

253. From the dyke above mentioned, cutting the slates. The high range of hills that culminate in Mt. Josephine, back of Grand Portage, seem, from the lake, to rise from the point west of the E. Palisades, where the rock (540) strikes inland. Their outline and general character resemble the range back of Double bay, further west.

254. Is a quartzose conglomerate, firm and hard, with fragments of slate and quartz pebbles, from the N. W. side of Portage Bay Island. This lies in large fallen pieces on the shore, the island rising perhaps 80 feet. These masses are finely stratified, and even show false bedding; a few rods beyond these fallen pieces, (E.) this conglomerate is in place, dipping S. 10° E., at an angle of 8 or 10 degrees. It shows at least 20 feet, and is cut by a dyke nine feet wide, which is apparently connected with the trap (?), No. 255, that there lies on the conglomerate, and which may have come from overflow from this dyke.

255. This overflow comes down to the water at once and hides the conglomerate, and rises perpendicular about 12 feet. It weathers very rough and open-angular, from containing fragments, apparently, of rock from contiguous formations, that were not wholly molten.

256. Sandstone; of even grain and bedding, lying between layers of trap-rock immediately over No. 255.

257. Gray, thinly-bedded, hard, quartzyte, styled *siliceo-argil-*

laceous shale, by Norwood; at a short distance having the aspect of a bedded slate, probably belonging to the slate formation of No. 252; from the west side of Hat Point, near the extremity, overlain by the next. On the east side of the point can be seen numerous dykes cutting this rock, which probably has a thickness of 500 feet.

258. Basaltic trap-rock, overlying No. 257, and rising at least 150 feet; finally culminating in the summit of Mt. Josephine further north.

259. From layers underlying No. 258, on the east side of Hat Point; lower in the strata than No. 257, but conformable with them apparently, and forming a part of the same terrane; a gray quartzyte, or hardened sandstone, with rounded, apparently concretionary spots (¼ to ½ inch in diameter), of a reddish color; darkened by organic matter (?). Compare No. 270.

260. Near the head of Wauswaugoning Bay a dyke runs S. 45° W., and forms, for a short distance, the shore-line, containing a calcite vein in the center, about 4 inches wide. This is about 20 inches wide, but it so affects the rock which it cuts that it also becomes closely jointed, and almost columnar. The width of the dyke cannot be certainly determined, as another large ridge coming from the N. E., at an angle near oblique to the coast unites with it at its western end. Near this point another calcite vein, five to eight inches wide, crosses the former in a direction nearly E. and W. Embraced in the calcite are small lumps, and almost perfect rhombohedrons of hæmatite. Samples are from the dyke running S. 45° W. The rock (No. 257) cut by this dyke dips S. at an angle of about 15 degrees, and is rather more like a quartzyte than in some other places. A patch of this is included between these dykes that intersect each other, forming a triangle. The long side of the triangle is formed by a dyke running along the shore, rising from two to eighteen feet, but continuing further east for at least ¼ mile, horizontally columnar. The other sides are made by N. E. and N. W. dykes that unite a short distance inland. The first shifts its course a little east of a short pebbly beach, and also sends off an oblique spur which runs nearly south into the bay. In connection with this the slate also reappears, dipping about into the bay—though slate is hardly the word to apply to this rock. It is in some of its layers a pinkish quartzyte, but the greater part is black, or gray-black, sometimes with a shade of blue. It is more aluminous in its dark parts, and is fissile also, but its fissile parts are so strongly protected by the firm and

quartzose beds, which are closely jointed, and often with beautiful symmetry, that they do not weather out much more easily than the rest. Sometimes a layer, however, separates from that below it, over a space of a few square feet, and the argillaceous parts thus exposed become finely, conchoidally jointed, and might be styled botryoidal, like some decaying shale beds.

261. The hill on the N. E. ¼ Sec. 25, T. 64, R. 7, E, rises by aneroid 520 feet above the lake. The Mt. Josephine ridge rises much higher, sweeping, in one of its spurs, toward the northeast past the head of the Wauswaugoning Bay to this point. It is at the summit made of the rock of this number, which is a doleryte like No. 260, of a slightly greenish tint. This fairly represents the rock of all these hills to Grand Portage.

262. Below No. 161 can be seen slaty red quartzyte beds with slate, in the southern slope of the hill, dipping toward the north, or into the hill, at a low angle. The hill is largely made up of this kind of rock. Another smaller dyke, running E. & W. rises into a low hill on the south side of the main hill, and cuts the same quartzyte, which here is more nearly horizontal, yet dips some in the same direction.

263. Is from an overflow of igneous rock, rising irregularly, basaltic perpendicularly, that forms the straight high coast that makes a sharp angle in Wauswaugoning Bay. It is a magnetited doleryte. While it is basaltic on the N. W. side, it is bedded and dips to the S. E. in following it toward Birch Island. This is on N. E. ¼ Sec. 30, T. 64, R. 6 E. It finally becomes overlain by layers of quartzyte—which layers are curved and twisted as if by heat from below. They could not have been deposited as a sediment on No. 263 when the latter was cold, but must have been previously deposited and then disturbed by an injection of the molton rock under them. Angular pieces of the quartzyte are enclosed in No. 263. changing the weathering color and the composition in spots, reminding one of the "red rock" embraced in the "Rice Point Granite" at Duluth.

264. These samples show this enclosure of quartzyte, and also changed quartzyte; from the coast due N. (by compass) from Birch Island. In some spots are specks resembling graphite, with a few specks of pyrite.

265. Is from the upper part of No. 263, where in contact with the quartzyte. The quartzyte is slaty. No. 265 is geodic with fine crystals of quartz (?) surrounded by graphite or mingled with

it, (some of this soft mineral is light-colored, with reflecting surfaces, like talc).

Birch Island is caused by four hardened belts in the quartzyte and slates, from 5 to 10 feet wide, which run E. and W. making the slates darker and in spots basaltic, and yet showing in other spots their bedded slatiness. These belts resemble dykes of igneous rock; and they run as a reef almost to the shore northwardly. The point east of Birch Island is mainly made of red quartzyte, which rises here about 35 feet above the lake, but yet dips south into the lake at an angle of about 8 degrees. It breaks off in steps, back from the shore, from ten to fifteen feet high, and some of it rapidly breaks up into blocks of a few inches. This is especially the case where the hardened belts (or dykes?) from Birch Island cross the point.

265. B. Samples of this quartzyte, showing also glaciation (?) in curving fractures over the surface, like that described on the Rock county quartzyte. But these curves present their concavities toward the S. W. and their convexities N. E., requiring, under the theory of their glaciation applied to Rock county, a movement of ice toward the N. E. These curved fractures have penetrated several inches—some of the larger ones—though this may be due to the continuation of the checks begun by glaciation, by weathering and frost since the glacial epoch. The formation is in most respects very similar to the Rock county quartzyte. But in some places it is conspicuously basaltic, and often contains crystalline grains resembling flesh-red feldspar, as well as darker grains.

275. A. Samples from the darker and firmer parts (as at Birch Island), that appear like dykes.

The coast line for a mile east of Birch Island is formed by the same quartzyte, crossed by several dykes. They cut the quartzyte, running E. and W. or very nearly so. One which is about 25 feet wide has a narrow calcite center, 2-4 inches, and some pyrite. This sometimes becomes two or three veins.

266. From a dyke-rock containing scattered pyrite.

267. Basaltic rock from the main vein, containing a calcite center, and which is about 25 feet wide.

267. A. Calcite and ore from No. 267.

268. Blackened quartzyte, with red (hæmatitic) specks; from near the dyke No. 267. This is of a dark color, but represents the prevailing color.

269. From Island No. 2, being the easterly of the first two islands near the coast; a porphyritic doleryte, the larger crystals be-

ing of a triclinic feldspar. The whole rock is gray, and has small grains of pyrite. The whole island is formed by a dyke of No. 269, flanked by a little quartzyte and slate near the water. The dyke is about 50 feet wide, and the island is not much more.

270. Graphitic rock; Pigeon Point, S. W. ¼ Sec. 32, nearly on the axis of Pigeon Point. This rock is charged with graphite, in the form of nodules from the size of a pin-head to ½ or ¾ inch in size. Some pieces are two or three inches across, and in the working for silver in a shaft some were found more than a foot in diameter. The rock also contains some native copper and pyrite. It embraces irregularly angular patches of quartzyte, and over the exposed surface are patches very rich in graphite. There is but little soil. The rock is chipped, and lenticularly and roughly jointed, or laminated. It is stained outwardly with iron rust. This is plainly a metamorphic rock. It can be traced two or three miles east and west. The graphite, while occurring more or less in the rock on either side, yet is found most abundantly in veins and joints in this quartzyte, over a belt 20 to 40 feet wide. (See No. 552).

271. Finely graphitic quartzyte; from the same place as the last.

272. From the vein on S. W. ¼ Sec. 32. This vein is supposed by the parties owning it to be a branch from that wrought on the trail to Parkerville. No working has been done on it, but the croppings show heavy spar, carbonate of copper, and amethystine quartz, the bulk being heavy spar. Runs N. 20 deg. W.

Crossing the graphite belt nearly north and south is a wide vein near the trail to Parkerville, of calcite and quartz, the latter sometimes being amethystine. This was wrought in 1874, by A. A. Parker, at points not far from the south shore of Pigeon Point, but without encouraging results, although the tests made were not sufficient to prove the vein. (See Report for 1878, p. 15.)

273. S. W. ¼ Sec. 32. From a dyke running N. 60° E., crossed by the vein No. 272.

About an equal distance east of the main N. and S. vein (wrought by Parker) is another vein about 8 inches wide, seen near the water level, which widens out toward the north, involved with much quartzyte, and extends, presumably, under the water to the south side of Susie Island, where other working has been done.

The rock, generally, of the region, appears to be quartzyte, but it is crossed by numerous dykes, generally E. and W., which tilt and modify it, rendering it nearly black in some places, and also

give it a basaltic form. The mining locations are on veins running nearly N. and S., following joints and other openings in the quartzyte.

274. Coarsely porphyritic form of the igneous rock of the country; from near the trail to Parkerville, about ¾ mile north of the lake shore. This rises in a low hill, and superficially disintegrates into gravel under the weather. This is just north of the point where the trail runs over a stony beach, which by aneroid is 52 feet above Lake Superior.

The large central vein mentioned as occurring on the south shore of Pigeon Point, formerly wrought, can be traced to the valley of Pigeon river, where it appears in a high bluff back of Parkerville. It is here about six or eight feet wide, and has quartzyte on the west side, and a rock similar to No. 274 on the other. It here contains considerable barite. It seens to extend beyond into Canada, to the first range of hills.

The slates and quartzytes at Pigeon River Falls dip south at an angle of 15 degrees. The falls come down in a direction S. E. over a dyke running N. 50° E. A short distance below the falls another dyke crosses the gorge, running nearly E. and W. (E. 10° N.) The falls have cut the former dyke more than half its width, and have 35 feet left.

275. From the dyke at the brink of Pigeon Fiver Falls, running N. 50° E.

276. From the dyke just below the falls running E. 10° N. The falls descend 70 feet purpindicular. These two dykes seem to converge toward the hill where No. 261 was obtained.

277. Porphyritic basalt, from a small Island west of Susie Island, south of the island which furnishes No. 269. This island is caused by this dyke, but has the countrv quartzyte on the flanks. On the east end and north side it dips a little east of south, or as the slates at Pigeon River Falls. It rises about 25 feet.

278. Is from the east end of the long island west of Susie Island, next south of No. 277; from the main dyke of the island. This island rises about 25 feet and has slates and quartzytes on the flanks—at the west end of the island beautifully ripple-marked. At a small dyke near the west end of the island the slates are caused to dip more rapidly on the west than they do on the east of the dyke. This dyke is about 4 feet wide.

279. From the dyke at the west end of Susie Island.

280. Rock, like No. 269, and in its bearing: Forms the north point that encloses the long bay on the east end of Susie Island,

cutting the quartzitic slates that dip south on each side. These massive dykes have generally the outward form of Roche moutonne, and near the water occasionally show glacial lines running in the direction of the islands.

281. From about half a mile from the east end of Susie Island, on the south shore, the supposed continuation of one of the veins from the main-land of Pigeon Point. It shows heavy spar only near the water, but the vein itself is about three feet wide,* the ore (bornite (?) and chalcopyrite, being distributed through the dark rock-mass of the vein, which seems to be a breccia of basalt of the region. There are a number of similar veins (four of them), but showing no spar, running in the same direction near this vein, some of them being as wide; and still further east are several more.

282. Prophyritic greenstone, from the main dyke of the north part of Susie Island. This contains orthoclose and plagioclase as well as some quartz and hornblende.

There is a spar veining running E. and W., or with the direction of the island, visible under the water near the shore, about ¼ mile west of the vein numbered 281. It is about 8 inches wide, and can be seen about 25 feet. It pinches out toward the east, and seems to also toward the west. There are several narrow spar veins crossing Susie Island, and the little island next west, nearly at right angles.

283. From the larger little island at the west end of Lucille Island. This rock outwardly appears to be exactly the same as the last, but it contains some pyroxene and no quartz.

284. From the main dyke (?) of Lucille Island, on the south side. The dyke itself is horizontally basaltic toward the west end of the island; and a part of the height of the island is caused by a heavy overflow, but perhaps not from this dyke. This dyke "hades" to the south, and is a coarse porphyritic greenstone. The samples are from that part that is dyke-like. The surface slopes toward the lake. In other parts this island is certainly bedded, and embraces parts of the slates, all dipping south; but the slates are nearly lost in fusion.

Lucille is the highest of all these islands, rising about 100 feet. There is little or no slate on the outer islands, but more and more on those toward the shore,

285. Red rock, from the first island N. W. of Belle Rose Is-

*Late working on this vein proves very promising, the vein itself becoming more defined, and wider, a few feet below the surface.

land. The south side of this island is conspicuously red with this rock, but the north side appears of the usual color. It is embraced between two or three narrow basaltic dykes. As the dykes crumble by reason of their more close jointage, the surfaces of this red-rock stand out in view. The island next further N. W. appears reddish the same way on the south side. None are red on the north side.

The island south of Lucille Island is a bare rock, in form like the rest mentioned, but has no soil, rising but little above the water.

286. Black basaltic rock, from the narrow dyke adjoining No. 285.

These islands, with perhaps the exception of Lucille, are all built on the same plan. They are igneous at the center, and are sometimes associated with some slate on the flanks. They are sometimes composed of two or more large dykes, and frequently show crossdykes radiating from the main line. The dykes are shaped and distributed as the slates broke on the upheaval of the land-ranges or hills, since the slates always dip toward the lake. These dykes have no effect on the dip of the slates—with perhaps one exception, which is visible on the south side of Lucille Island, near the west extremity, where there seems such irregularity as to suggest an independent fracture or outflow.

Lucille Island consists mainly, so far as height is concerned, of successive beds of massive greenstone, which in their lower parts are somewhat slaty, as if the slates at first were embraced, and they all dip lakeward, but a wide dyke runs from one end to the other. The islands are scantily wooded, the slaty ones more so.

The point that encloses Morrison's Bay is a quartzyte monoclinal, that dips to the lake. The bay has a pebbly beach, but with rocky outcrops of the same kind near the bite of the bay, and also on the coast about north from the point. The last runs east so as to enclose Clark's Bay in the same manner. The point, however, enclosing Clark's Bay terminates by a dyke about 20 feet wide, which runs also through the islands off this point. The islands and the point have the same structure—an immense dyke that "hades" to the south. In this dyke near the point are two crooked cores of calc and heavy spar carrying pyrites.

The coast of Clark's Bay is wholly rocky, except a short inverval at the head of the bay, and the hills on the north side rise perhaps 125 feet, composed of a huge dyke that forms, apparently, the axis and core of Pigeon Point peninsula. The points enclosing Clark's

and Morrison's Bays are nothing but repetitions of the off-lying islands further southwest—sudden outbursts of trap through fissures in the quartzyte causing scattered islands, or sharp elevations. Back of these two points are traces of the lake-shore action, that once actually made an island of Clark's Bay point, and also ran far inland back of Morrison's Bay. The same phenomenon is repeated in Pigeon Point itself. It was formerly an island, and Pigeon Bay was connected with Wauswaugoning Bay. Low flat land now occupies the intervening space as a terrace of Pigeon river. Parkerville is on this flat (or "cypress swamp"), which extends to Wauswaugoning Bay, being about a mile and a quarter in area.

287. From the big dyke (like No. 274), the axis of Pigeon Point, near the location of Baker & Kendrid's barite vein.

288. Fine green rock, from the shaft at the barite vein.

288. A. Calcite, barite, &c., from the shaft.*

288. B. Samples from vein (b) near the shaft.

289. The country rock, at the barite vein. This is $\frac{3}{4}$ quartz.

290. Fair samples of the quartzyte of the region—the chief rock of Pigeon Point peninsula, as exhibited on the south shore: obtained three miles west of the extremity. This is a dark-red or brownish quartzyte becoming black near the dykes, and in some places having red orthoclase mixed with the quartz grains.

Quarter of a mile east of Kindred & Baker's shaft is a dyke 45 feet wide that runs south 40° E. It is unnecessary to mention and sample all the dykes, some of which are narrow and run in different directions. A large dyke terminates, or runs under the lake, with a high hill at the shore, at the point where the section line between 26 and 27 strikes the south shore. Three smaller dykes terminate in a similar way a few rods west. Other points are formed in the same way. At the canoe portage Canada can be seen across the point, and the point is very narrow. This high point is just west of this portage. Approaching the extremity of the peninsula, the igneous rock becomes more frequent in outcrop, by being interbedded, and by frequent branch dykes. The dykes rise like those in the islands and fall again soon. (See Nos. 604-616.

291. From the extremity of Pigeon Point Peninsula (compare No. 603). This seems to be the principal rock axis of the peninsula, and probably in the line of bearing of Nos. 287 and 274. This rock is not evidently a dyke here, but a massively bedded, or

*For a brief account of this location, and the ores found, consult the Seventh Annual Report, p. 16.

coarsely jointed formation which extends west, and soon rises over 50 feet from the water, and shows a basaltic, mountain-like structure. It resembles the rock and structure of Rice Point, and may be parallelized with it in age, and here is associated, as there, with a red, metamorphosed rock. Here, however, it is a part of the Animikie beds, of Dr. T. Sterry Hunt, which would therefore seem to be only a downward extension of the Cupriferous Series. This rock breaks down at the canoe portage, about a mile west of the extremity of the peninsula, and only a pebbly beach forms the continuation of the land, which is but few rods across.

292. The next rock, just west of the canoe portage, on the north shore of the peninsula, forms a similar kind of coast; also is heavily jointed and bedded like No. 291; but it is red with orthoclose. The microscope reveals also hornblende and quartz; occasionally, also, is a grain of a milk-white, foliated, soft mineral. This is a granular rock, derived from the fusion and crystallization of the associated sedimentary beds. It weathers and parts as if a conglomerate near the water. This rock continues but a short distance, making one blunt point, when the features and color of No. 291 return again. (See the notes on Nos. 604–613).

293. From the north shore of Pigeon Point, about a mile and a half from Pigeon river. This forms the coast line, and high hills, and fairly represents the north shore of the peninsula from the Point to this place. There is no quartzyte. Near this point is a high bluff of fine basalt, closely and irregularly jointed, crumbling out in small angular pieces, continuing about 50 feet, forming a round, broad point.

At about half a mile from the river the coast-rock changes, becoming quartzyte and slate, dipping to the south. Just here, or within a rod or two, appears the baryte vein that is shafted by Kindred and Baker on the south side, but it is in the slates and quartzyte. It is about 25 inches wide. It here runs E. 25° S. The mass of the vein is baryte, but seems also to contain calcite, as the baryte is porous and cavernous, and is separated from the walls by solution of some other minerals. The same ores in small quantities are visible in the veins and small included altered pieces of slate or quartzyte, especially the pyrite. The slates and quartzyte continue to the mouth of the river, but there a range of hills sets in immediately on the south side, which continues to the south of Parkerville, where they consist of coarsely porphyritic rock, like the rock No. 274. These hills are wooded down to the river. This range dies out before reaching Wauswau-

goning Bay, and to the north runs a larger range from which was obtained No. 261. West of the last vein mentioned, about 400 feet, is a two foot vein of calcspar, near the mouth of Pigeon river, running S. S. E, in the traprock of the country. It dips slightly to the east. No working has been done here. Superficially it shows only calcite, sometimes saccharoidal.

Mayhew's location, which is about 3 miles west of Cascade river, comprises a series of veins in a loose network, running in various directions, varying from ½ inch to 6 inches in width. They appear under the water near the shore, and show white, embraced in the traprock of the country. They contain calcite, laumontite, stilbite and other minerals. The ore is what is styled "gray copper ore," but without the authority of any analysis by the survey. It appears like that from the vein on Susie Island, south of Pigeon Point. The rock round about is frequently veined, and parts with red "heulanditic" coatings, so named by Norwood. It crumbles, on weathering, to a coarse gravel, of a dirty green color. It also has hæmatitic red spots on the weathered surface. The main direction of the net-work of veins is W. 19° N., having a width of about four feet. But the lead that has been wrought by shafting produced masses of the ore from between wall rocks, indicating a width of ore of 4 inches.

From Grand Portage to Squagmaw Bridge, along the International Boundary.

From Grand Portage Bay the portage trail follows the main creek about a mile and a half, when it leaves the valley of the creek and continues more nearly in a right line, but to the east of the creek. At three miles on the trail it crosses a creek which runs northward into Pigeon river and is cut about 50 feet into the non-terraced deposits of the plain. The trail rises 537 feet above the lake at a point half a mile south of this crossing, the ascent being gradual all the way, and nearly in a right line, over a glacier deposit that also gradually rises from the flat on which the church stands at Grand Portage. A glacier valley now filled partly with till extends thus northward from Grand Portage, and has by its smooth upper contour determined the location of the portage trail. Before reaching the highest point there is a level tract of half a mile of glacier clay, good land, once timbered, now burned over. Passing the notch in the hill range, the trail soon descends about 70 feet to this creek, and the main glacier plain, which is here a

mile wide (No. 5), and rises toward the northwest. The ice-movement was toward the east or southeast, sending a spur from the glacier through the notch where the trail goes, that finally reached Lake Superior. The principal glacier plain is bounded on the north by another range of hills resembling those along the south side, thus holding this ice-flow in a trough. This plain is a fine tract of clay land, suitable for all cultivation adapted to this latitude. The soil is not strong, but mostly a fine clay, or a pebbly clay. The hill immediately south of the creek crossing rises, by aneroid, 335 feet above the creek, and 225 feet higher than the trail.

294. A globuliferous weathering doleryte (perhaps a melaphyre), from the hills next north of the glacier plain above described, near the point where the "Arrow river trail" crosses them.

The hill to the south of the creek-crossing, rising about 355 feet above the creek, is of igneous rock, dark colored, weathering grey, consisting of plagioclase and pyroxene exactly like the rocks of number 294, 293 and 291, and this rock seems to constitute the whole of the hill, and of the country about. Yet judging from the slate seen along the lake shore, forming the lower slopes of the hills, the slate and quartzyte formation is the real rock of the country, and this igneous rock simply has been thrust through it. Being more firm, and afterwards glaciated, it has come to be nearly the only rock visible. This is also farther indicated by the presence of much fragmentary slate in the drift clays of the valley, and even of some fragments of slaty quartzyte on the upper slopes of this hill. There are also some gneiss boulders on the very top of this hill.

This hill is only one of a short series running about N. E. and S. W. overlapped *en echelon* by others further east. There is here no evidence of any extensive dyke, or line of fracture in the stratified rocks continuous in one direction, but rather of several short fractures.

From the creek crossing above mentioned the trail ascends gradually over a deposit of till, mainly smooth, to the summit of the portage, 782 feet above Lake Superior, and five miles from Grand Portage village. This clay deposit was once wholly wooded with pine, aspen, birch, spruce, tamarack and cedar; but in 1873 it was devastated by fire accidentally set by an Indian. The hills also were timbered but now are charred and treeless as far as the eye can discern. Toward the northwest, this smooth clayey drift deposit continues to the summit near which is a frequent stopping place for voyageurs. A low cleft, among some trap rocks, near

the trail on the right, furnishes water and a half way stopping place. The whole country here, however, is high and clay-covered, nearly on a level with the top of the hill at the creek crossing. The water found is on a lower level, and on the descent to Pigeon River. By Aneroid, Pigeon River at the end of the trail is 697 feet above Lake Superior.

There is but little rock exposure on the trail, after leaving the creek crossing mentioned, and the most of that is near the upper end of the trail, or within one-half mile of Pigeon River. In one place the trail passes over a glaciated surface of rock No. 294, nearly in the line of the range from which 294 was taken, but further north, but the rock does not rise above the trail. In passing further, a few other similar exposures occur, but some of them are of a harsh non-igneous rock, somewhat slaty in places, viz:

295. Bedded, of a greenish-gray color, fine grain and somewhat slaty structure; near the upper end of Grand Portage trail; probably from the slaty formation of Grand Portage. Just below the portage landing Pigeon River has a little rapid and then all the way below there is no possibility of canoeing till after passing Pigeon River Falls near Parkerville. The rock which first appears near the portage landing is No. 295, dipping S. 10° E. at an angle of about 10 degrees. The course of the river here is north; it continues about a mile northwestwardly (up stream) when a portage of ¼ mile is made up an ascent of 67 feet. This is known as Partridge Portage. Except a strip of about two miles on the grand portage beginning at 4¾ miles from Grand Portage village, the whole country is burnt off. Immediately below the upper end of Partridge Portage is a fall in the river, nearly perpendicular, of about 40 feet. The rest of the descent is in the rapids. The brink of the falls is of slate, ripple-marked, dipping S. about 12 degrees.

296. The slate of the brink is immediately replaced in the gorge by a dyke (296) which at first is perpendicularly jointed; but after about 75 feet it becomes more globuliferous-weathering, and crumbling. These two aspects together occupy a distance of 110 paces down stream, and are the axis of the uplift producing the hill range. This is supposed to be the same hill range as that from which was obtained No. 294. Below this axis comes a rock like No. 295. This dyke No. 296 is nearly cut through in the recession of the falls, there being but a few joints of it left standing vertical toward the foot of the fall. These break the fall of the water. The slate will probably endure the erosion better than

the dyke, its position (dip up stream) affording greater protection from the current. The dyke here runs W. 5° N. About 25 feet below the foot of the fall, a narrow vein of pyrite and calcite crosses the gorge. In high water it is entirely covered. The perpendicularly jointed part of this dyke which receives the impact of the falling water at present, has very much the aspect of being a metamorphic condition of the slates themselves; basaltified by the real igneous rock which is seen to crumble with a globuliferous disintegration.

Canoeing about four miles the ascent is about 5 feet, when the river becomes shallow and the canoe is dragged slowly for nearly a mile, the ascent being 17 feet, to English Portage, when an ascent of 15 feet ensues, the portage being about $\frac{3}{4}$ mile. At the upper end, where the rapids occur, is a low exposure of

297. Rock like No. 296. Toward the S. W., about a mile, is visible a hill rising about 300 feet above the river. This rapid is a part of the effect of this hill-range. Another hill, on the Canadian side, is in range N. E. from this, the rapids being between them.

Above English Portage canoeing one mile gives an ascent of 3 feet, when the fourth portage is reached. This extends about $\frac{3}{4}$ of a mile, with an ascent of 25 feet. Adding for ascent to the foot of S. Fowl portage (canoeing) 2 feet, and for the ascent of S. Fowl Portage (5th portage) to S. Fowl Lake, 102 feet, the hight of S. Fowl Lake above L. Superior is found to be 933 feet.

The two portages below the S. Fowl portage afford no rock exposure. A hill range, however, can generally be seen off south of the river, one or two miles away, between the last portage and S. Fowl Portage. The drift clay is everywhere red. The S. Fowl Portage is one mile long. A trap hill rises to the hight of 1,260 feet above Lake Superior, just at the landing place at the head of S. Fowl Portage, near the foot of S. Fowl Lake, which is perpendicular from the lake shore, except a coarse and high talus. This hill is 327 feet high, by aneroid, but it is only one of a series of hills running west 25° N., two of which, about 100 feet higher than this, are on the United States side of the river, and also near the lake, but bearing away from it. West from this (or S. W.) is a high and large range of wooded hills running N. W.

298. Is the basaltic rock composing the top of the hill at the foot of S. Fowl Lake. At the foot of this hill, on the west side is a copious talus, which also lies in a shaded gorge which slopes N. and is protected from the warm sun of the summer. At the foot

of this talus, where this gorge approaches the lake, near the end of the trail, is a spring of ice-cold water, which is said to never dry up, nor to become warmer. It is probably fed by perpetual ice protected in this gorge by the coarse fallen pieces of the talus from the warmth of summer. The presence of this perpetual ice is further indicated by the rank mosses growing on the rocks about, sustained by the condensed moisture due to the coolness of the gorge.

About one-third of the hight of this hill is composed of the black and quartzyte slates, dipping south at an angle of about 8 degrees. This is visible and most accessible on the north face of the bluff. The rest above is an igneous overflow, in basaltic structure perpendicular to the slate beds.

299. Fragment of the slate from below No. 298; ten feet below contact.

At the outlet of S. Fowl Lake, which is between two bluffs of igneous rock, the west one being about 100 ft. high, there is a dyke of black basalt about 8ft. wide, passing through the doleryte (298) running E. and W.

A short distance above N. Fowl Lake, is the foot of the 6th portage, going over Canadian soil, which, with a partial unloading of the canoe before reaching it, on account of shoal water, amounts to about ½ mile, and ascends 48 feet, to the level of Moose Lake, 985 feet over L. Superior. Ascent over South and North Fowl Lakes perhaps 4 feet. It is noticeable that more land is burnt over along here on the United States side of the boundary than on the other. Some tracts largely covered with pine at first have been devastated on the United States side, especially along North Fowl Lake and Moose Lake. The south side of Moose Lake is formed by slate hills, or a ridge of slate made by the strike, the dip being toward the south or a little west of south. The country is largely drift-covered; indeed has been everywhere glaciated, but as yet it has been impossible to ascertain, by glacial marks *in situ*, the direction of the movement, though it was probably the direction of the valleys, eastwardly or south-eastwardly. The forms of the hill-tops, and particularly that at the foot of S. Fowl Lake, are like that seen in the Saw Teeth Mountains, and generally along the shore of Lake Superior. They slope gently toward Lake Superior, but are precipitous or perpendicular toward the land. Hence, looked at obliquely from a distance, they occur in very much the successive outline as the teeth of a saw. It seems as if the precipitous sides facing the northwest are caused by the action of

glacial ice on the geological structure. If the hills are entirely of igneous origin, and their axes are deep dykes running to the interior of the crust, then they are bald and basaltic on that side because of the greater violence of glacial forces from that direction. But if the hills are caused by overflows of igneous matter, with the strata below dipping towards the lake, the saw teeth form has been wrought out more easily by the combination of glacial causes with a favorable direction of dip,—which is the case in the bluffs south of S. Fowl Lake, and east of N. Fowl Lake.

300. Coarse, almost porphyritic, igneous rock. S. W. ¼ Sec. 30, T. 65, 3 E., from a hill composed partly of this and partly of slate. This hill rises 485 feet above Moose Lake, 1,470 feet above Lake Superior, and 2,070 feet above the ocean, being one of the highest points yet measured in the State. This is but one of a series of similar hills, some of which perhaps rise higher.

West of Moose Lake is the seventh portage, on the Canada side of the boundary, about ½ mile long, rising 130 feet. This trail passes through a surveyed mining location. It goes over the slates of the country, though the rock is oftener a gray quartzyte than a true slate. It is interstratified with what appears like true roofing slate, and is often black with contained carbon. It is all apt to be in beds less than 3 inches thick, but the gray quartzyte also appears sometimes in beds of 6 or 8 inches or a foot. The Pigeon river here is very insignificant.

Passing a small lake the eighth portage begins, which is also on Canadian soil, and about 1-6 mile long, ascending 15 feet.

Passing another small lake the canoe route has its ninth portage which leads to Mountain Lake. These two small lakes are styled Twin Lily lakes, named from the abundance of *Nymphæa odorata* which spreads its leaves all over their surfaces. Mountain Lake is 1,150 feet above L. Superior.

There is a hight of land on the section line between Secs. 21 and 22, south of the "narrows" of Mountain Lake, which rises 353 feet above Mountain Lake, or 2,103 feet above the ocean, being the highest land yet measured in the State. A few rods further west the ridge rises 15 feet higher, and in the distance (S.) is a ridge which is probably the real "Mesabi," which rises several hundred feet higher.

These hills are all short mono-clinals of gray quartzyte, with beds of argillaceous and black slate, dipping uniformly in a southerly direction, and covered with a greater or less thickness of the traprock of the country (like No. 300), the trap sometimes being

over one hundred feet thick, but generally less than fifty feet, and often the only rock seen, the lower beds being hid by the copious talus. The slate in some places has a dip slightly S. W., and the inclination amounts usually to about 8 or 10 degrees. The trap itself also dips with the slate, so that the hills have gradual slopes toward the south and steep slopes toward the north, or are perpendicular—indeed they most frequently are perpendicular for about 25 feet from the top, or even 100 feet, the trap having a widely basaltic structure, which causes it to fall away in perpendicular columns; the slate and quartzyte also have frequent perpendicular jointage planes, which also facilitate the perpendicular breaking of these beds. The quartzyte is evenly and conspicuously bedded without any confusion, but alternates both gradually and suddenly, with the black argillaceous slate. The most of it, so far as seen to this place, is gray quartzyte. This quartzyte must be an immense formation, as it is that seen at Grand Portage, and all over Pigeon Point and the islands of the point. Still it cannot be estimated, fairly from what appears to this place along the boundary line, since that line nearly coincides with the line of strike.

Several important questions, pertaining to the geognosy of this formation, arise in an attempt to describe it, which must for the present remain unanswered, but which perhaps future examinations may solve.

1st. Is this trap older than the uplift of the hills, or did it come over the country when the uplift occurred?

2d. Are the dykes that are seen crossing this trap (as at the foot of S. Fowl Lake) of the same age as the trap, or are they subsequent to it?

3d. How much of the topography here is due to glaciation?

4th. Do the monoclinal hills run under each other, or are they each separate and isolated uplifts?

5th. Can these beds of supposed igneous rock be due to a change in the sedimentary rocks instead of igneous overflow?

6th. Why is there an entire absence of amygdaloid?

The portage from Mountain Lake to Rove Lake descends 3 feet, passing over a divide of perhaps 20 feet high between the two lakes. Hence the "dividing ridge" on the boundary line is 1170 feet above Lake Superior, or 1770 feet above the sea level.

301. Vein matter from Kindred and Baker's shaft on the White Rose vein, near Arrow Lake in Canada. This is about 1¼ miles north of the east end of the first lake west of Mountain Lake.

For an account of this location the reader is referred to the Seventh Annual Report, p. 17.

302. . Vein matter from Baker's shaft on the White Rose vein.

It seems a common thing to see quartz veins near the perpendicular walls of the mono-clinal hills, as if by a series of faults they had been located there on the upheaval and breaking of the rock. They are apt to be hid by talus on the north side of these hills, but are sometimes seen standing by the side of the bluff, or adherent to it, some distance above the talus.

Daniel's Lake is 28 feet lower than Rove Lake or 1119 feet above Lake Superior. Some very high hills of slate and quartzyte, covered with the trap rock of the country, are along the south side of Rove Lake running westward to the south side of Daniel's Lake.

The portage from Daniel's Lake to Birch Lake (Bearskin Lake on the plats, wrongly named by the surveyors) ascends 24 feet; from Birch Lake to the lake south of Birch Lake the portage ascends 7 feet; thence to the lake on section 6, T. 64 N. 1 E. 51 feet, making this lake 1201 feet above Lake Superior; thence to Bearskin Lake, descent 23 feet; thence to large lake N. E. ¼ Sec. 9, T. 61, 1 E, descent 16 feet, 1162 feet above Lake Superior.

There appears to be no change in the geology of the country, except that the mono-clinal hills of quartzyte covered by trap, are not so high as along the lakes further north.

The portage from the last lake is on S. W. ¼ Sec. 1, and descends 6 feet to a lake on S. W. ¼ Sec. 1; thence a portage to Fanny Lake ascends 14 feet, making Fanny Lake 1170 feet above Lake Superior. For an account of mining operations on Lake Miranda, by Mr. Wm. P. Spalding, the reader is referred to the Seventh Annual Report, page 18.

Lake Miranda is 61 feet higher than Lake Fanny, and Pine Lake is 279 feet lower than Lake Miranda. The highest lake level yet measured is Lake Miranda, 1231 feet over Lake Superior.

Descent to McFarland's Lake, *via* Pine river, 1 foot; McFarland's Lake over Lake Superior, 951 feet. John Lake is about a foot lower than McFarland's Lake. The descent to S. Fowl Lake must be about 18 feet, according to the ascertained level of S. Fowl Lake.

Consult the Seventh Annual Report for an account of McFarland's mining location, page 20; also of Johnson's on the S. E. ¼ Sec. 32, T. 65, 3 E.

About ¼ mile east of Johnson's shaft is a bare glaciated surface of trap, crossed by the trail from John Lake. The whole surface

slopes south, toward the axis of the valley, and the marks generally run N. and S. and some also E. of N. and W. of S. There is here also a superficial checking, or chipping comparable to that seen in Rock county, but less closely set. The checks appear by the shape of the pieces, that come out after burning, as well as by the freshly uncovered surface where no fire has loosened them. Their concave sides are generally toward the northwest.

303. Apparently auriferous quartzyte from the large quartz vein near the south shore of Pine Lake, on S. E. ¼ Sec. 31, T. 65 N., R. 1 E. (Consult the Seventh Annual Report, p 21).

The small lake at the east end of Cariboo Lake is 90 feet higher than Pine Lake, and Cariboo Lake is 5 feet still higher, or 1047 feet higher than Lake Superior. Clearwater Lake is 1159 feet over Lake Superior; thence to Mountain Lake is a descent of 5 feet, making Mountain Lake again, after a series of scattered aneroid observations since leaving it, 1154 feet above Lake Superior—or 4 feet higher than by the former observation. This check on Mountain Lake, after an interval from Sept. 7th to the 15th, and through a line of elevations carried through Rove Lake, Daniel's Lake, Birch Lake, lake south of Birch Lake, lake in Sec. 6, T. 641, Bear-Skin Lake, lake N. E. ¼ Sec. 9, T. 64, 1; lake S. W. ¼ Sec. 1, Fanny Lake, Miranda Lake, Pine Lake, McFarland's Lake, Pine river, small lake east end of Cariboo Lake, Cariboo Lake, and Clearwater Lake, with intervening portages and various weather, is a proof of the usefulness and also the ccrrectness of the aneroid observations.

On the portage from Clearwater Lake to Mountain Lake the trail passes over an interval near the summit of the divide where the quartzyte dips N. W. Several short, low, sharp monoclinals occur, crossing the trail diagonally. They are inconspicuous compared with the mono-clinals dipping in the other direction. The high hill, however, facing on Mountain Lake, just east of where the trail strikes it, dips in the opposite direction. Another point where the slate dips northwardly may be seen along the east end of Caribo Lake on the north side.

In making the portage between Mountain and Rove Lakes one is struck with the simplicity of the international boundary line. It is the narrow, crooked Indian trail running between the lakes, and the United States land surveyors meandered up to it and set stakes, the same as to a lake shore.

Mud Lake is 125 feet below Rove Lake. The trail, in passing over this portage, runs on the top of a ridge which has the appear-

ance of a kame, for the distance of fifteen or twenty rods. This is somewhat nearer Rove Lake than Mud Lake. The ridge is steep on both sides, and over 50 feet high in some places. In others it is narrow and slightly deflected from its course. It runs rudely parallel with the valley in which the trail lies.

While the general explanation, already given, of the structure of the hills of this country is correct, yet there are exceptions and irregularities throwing the dip out of its southerly direction. Sometimes the crust seems to be faulted on both sides, or nearly all sides, of a hill, the trap rising basaltically above the talus nearly all round.

High hills border Mud Lake, especially on the south and west sides. The drainage from Duncan's Lake into Mud Lake, and thence to Arrow Lake and Pigeon river.

Rat Lake is 6 ft. higher than Mud Lake, *via* Rat Portage; and South Lake is 29 ft. still higher, or 1057 feet above Lake Superior. The outlet of South Lake is into Rat Lake. North Lake has the same level as South Lake.

Between North and South Lakes is a low divide, perhaps 40 feet higher than the lakes, which actually forms the divide between waters flowing to Lake Superior and to Lake of the Woods, and should be so designated on Minnesota maps, instead of the divide between Mountain and Rove Lakes. Mountain, Rove, Mud and South Lakes discharge into Lake Superior, but take the Arrow river channel through Canadian territory, to reach Pigeon river. This divide then is 1097 ft. above Lake Superior, and 1697 above the sea. North and South Lakes, being on the same level, probably have a connection, but their overland visible outlets flow in opposite directions. The divide between them is a low ridge of the usual trap of the country. The south shore of North Lake has a sandy beach at the portage landing, plentifully intermingled with colored flint and jasper. The "gunflint" beds are reported to be exposed on the portage trail from North Lake to Northern Light Lake, and between North Lake and the next lake north.

304. Guided by this, and the topography, the same beds were discovered in the long, low point separating North Lake into two arms. These beds are confused, but yet a part, probably, of the quartzyte formation seen all the way from Pigeon Point to this place, and underlie it. They are nearly a red jasper, or jaspery bloodstone, in some places red, but varying also to blue and greenish, and passing also to white quartz, the greater part being blueish-black. In the bloodstone the matrix of the red globules weath-

ers away faster than the globules themselves, producing a reticulated fine roughness on the surface.

305. Near the head of the bay, just east of the first narrows, in the outlet to North Lake, is an outcrop of this rock on the north side of the boundary. This, of course, underlies the gunflint beds. It is a granular rock, crystalline, rather coarse, firm and dark colored, containing much amphibole. Its other constituents are orthoclase and quartz, with a little biotite. It is in low, irregular knolls, and is veined and blotched with irregularities of composition, one vein being the next number.' (Compare No. 718).

306. Which is finer-grained, much lighter-colored and consists almost solely of grains of quartz and orthoclase, with scattered films of biotite.

Passing through the "narrows" there is a descent of four feet, into a slow, broad stream or narrower portion of the bay, known as Gunflint river. These narrows are not represented on the surveyors' plats.

There is, along this bay and stream, an unseen interval between Nos. 304 and 305, which may amount to two or three hundred feet, the space being occupied by water.

307. From the Gunflint series, a mile further west, on the south side of the long arm, very irony and carbonaceous. The quartzyte formation seems to graduate downward into the gunflint rocks. This rock is a carbonaceous and pyritiferous shale, firm and heavy, with flinty nodules, not well exposed, but embracing perhaps two feet.

There is a considerable current, and a descent of about one foot into Gunflint Lake, which, therefore, is 1,052 feet above Lake Superior.

A beach of coarse sand along the head of this lake, as well as that on the south shore of North Lake, presents a novelty in the characters of the shores of the northern lakes, which are generally either of bare rock *in situ*, or of pieces from the bluffs adjoining. This sand seems to imply a rock easily disintegrating in this series. The sand itself consists mostly of quartz and orthoclase, some of it being of granular rock like No. 306.

308. The trap of the country; south side of Gunflint Lake. Sec 24 T. 65, 3 W. (Compare Nos. 721-27).

309. Hydromica slate (?); from the north side of Gunflint Lake, about half way from the eastern extremity. This rock rises in knolls and hills one above the other irregularly disposed. The

slates stand nearly vertical, running E. 20° N. This passes insensibly into the next.

310. Rock, magnesian, yet harsh and firm, with grains of free quartz; of a light green color. Into this the slate graduates, back and forth. This resembles some forms of the slates at Thompson, on the St. Louis river. (See 469).

311. Greenish porphyritic rock (with albite?) having an imperfect, schistose and fibrous structure, and some free quartz; embraced much like veins in the slate No. 310. It is not vein matter, but gradually changes to the slate right or left, the slates standing nearly vertical and running E. 20° N. In this slate are also some large veins of milky quartz.

This outcrop is supposed to belong to what the Canadian Geologists have styled the Huronian. It underlies the quartzyte and gunflint beds, apparently unconformably. At least it is another and distinct formation from the slates at Grand Portage.

On the south side of Gunflint Lake, a little further west than the last, is a low outcrop of rock like No. 312, which occurs strewn in fragments along the beach more or less on the south side of the lake, and at the east end. When broken freshly it has the appearance of a gray quartzyte embracing fragments of flint, or finer quartzyte, somewhat like a conglomerate. The matrix is coated, on the weathered surfaces, with a film of iron-rust derived from the rock itself, but the siliceous fragments it embraces are not so coated. This appears again, in a low exposure, on the north side of the lake, about a mile still farther west, and here shows plainly a conglomeritic structure and composition.

312. Quartzyte conglomerate; from N. shore of Gunflint Lake, west of the outcrop of Nos. 310 and 311, in a belt running to the south of these. At the exposures of the rocks 310 and 311 the north shore is bent northward abrubtly, bringing the water upon them, the strike of No. 312 forming E. and W. points on either side, enclosing a bay which breaks down and covers No. 312. This conglomerate, or breccia appears on both sides of the lake, nearly opposite. The fragments are of gray quartzyte and flint, all angular, not water-worn. Sometimes the flint seems to run through the rock as if in its sedimentary position. The matrix is coated with an iron rust, derived from the oxidation of siderite which constitutes a large per cent. of the rock, making a permanent film all over it. The flinty pieces embraced in it are not thus coated. The whole is contorted in bedding and broken; it pertains to near the base of the series. (See after No. 927). This

carbonate of iron probably derived the carbon from the associated slates, which are sometimes black with it. In other places the iron is a sesquioxide—or in some places it seems to be disseminated as a sulphuret, as in No. 307.

313. Granite, from N. E. ¼ Sec. 24, T. 65, R. 4 W.

313. Granite (with garnets?), from S. E. ¼ Sec. 13, T. 65, N. R. 4 W. Rock of this kine seems to compose the range of hills that run westwardly from here, and also eastwardly, in Canada. Where this range crosses the river, there is a narrow place, and rapids (2 ft. fall); but south of this the level is that of Gunflint Lake. But in about 40 rods further north are falls and cascades, over the same rock, the descent being 14 feet.

315. Granite from the falls, next north of Gunflint Lake, (same as No. 800). This granite is similar to the rock 305, but has generally less amphibole and more quartz. This and that, and the last belong to the same formation and class of rocks, and are in the same range of hills.

After a descent by the river through rapids, about three feet, a small portage is necessary round a fall in the river amounting to 33 feet.

At the foot of this portage the level of the river was found, in 1878, to be about four feet lower than usual, even for low water, and a wide, freshly drained tract round the shores, showed that there had been some channel lately acquired by the river at a lower level, or that like Sunken Lake, in Presque Isle county, Michigan, some underground passage was at that time able to carry the whole stream, since the river wholly disappeared, having no visible overland flow. The last water seen at this place was 1030 ft. above L. Superior.

Making a portage of about half a mile the trail strikes water again after a descent of 52 feet, at N. E. corner T, 65 4 W. in a lake. Through this portage the rock is the same as No. 313 and 314. The country however is not so hilly as in the quartzyte and slate.

Passing two short rapids, one of 4 ft. fall, and the other of 2 feet, a portage is made on the U. S. side, to the level of a little lake, descending 18 feet, with the same granite all the way. Granite outcrops frequently through this town, along the boundary line, and sometimes has a bedding, though indistinct, that dips to the south. After striking the granite, the country loses white pine, and is supplied more abundantly with Banks pine. Norway

pine is also smaller, as well as all other trees. The knobs everywhere are *moutonne-ed.*

Below the last little lake a rapid descends 6 feet; then again by the same means 7 feet in two small rapids; and again 8 feet to Banks' Pine Lake, which is found to have a level of 930 feet above L. Superior. It is a long (4 or 5 miles) narrow lake, running N. N. W., reaching within $\frac{3}{4}$ mile of Saganaga Lake, its eastern extension swinging to the north and again east and southeast, with islands. Below this lake are two rapids, one of 8 feet and one of 6 feet, bringing the river to Saganaga Lake, with a level of 916 feet over Lake Superior.

316. Granite, from the rock a few rods below these rapids; occasionally dipping S. (See No. 799).

317. From an island in L. Saganaga, on Sec. 5, T. 66, R. 4 W.

Lake Saganaga* has many islands, and all are of the same rock, scantily timbered with Banks' and Norway pine, with a sprinkling of aspen and birches, and of course spruce, tamarack and balsam in suitable situations.

318. White quartz, from a mass on the east side of an island in N. W. $\frac{1}{4}$ Sec. 14. This has been some drilled into and blasted, but the quartz seems to be a barren mass. It is milky white, and has no ascertainable direction or form. It makes a conspicuous appearance on the coast, and extends along about 3 rods, rising about 12 feet. It does not appear inland far, nor on the other side of the island. It has an amethyst color sprinkled through it, and some fine galena scales. This rock falls down on the beach in blocks, and is scattered along like the granite. It has a jointing or imperfect, coarse cleavage structure similar to that furnishing the quartz chips at Little Falls. In hammering it breaks sometimes into angular small bits, and in the weather it parts in the same way.

319. On the next island north, at the S. W. corner is an outcrop in form and disposition like the last, but this is not of so pure a quartz. The quartz is somewhat granular and porous, and contains cubes of pyrite, which by oxydation give a rusty stain to much of it. This also has a conspicuous exposure in the midst of the enclosing granite. .

320. From the peniusula dividing Saganaga Lake, near the extremity on the N. W. side. There is quite an area here of the same; a variation in the rock of the country, being almost destitute of amphibole (a pegmatyte).

*The word Saganaga signifies *islands, or many islands*, and seems to be the plural of Saginaw.

321. From the same peninsula about $1\frac{1}{2}$ miles further west; consisting of quartz, orthoclase and chlorite, essentially being another variation in the rock of the country. The coast along is pebbly and stony, with occasional sand beaches in the bays. This rock, No. 321, appears to disintegrate more easily than the former numbers, and rarely appears on this coast. At a point near the first narrows the same rock is found in more frequent, and bolder, exposure, on the Canada side. At this point a short portage is made toward the W. into a small lake, over the rock next, with an ascent of two feet.

322. A finer-grained rock like No. 320, but containing some pyrite, from the first portage going west from Saganaga Lake, on the international boundary. This is Oak Portage, from a little burr oak growing there, the first seen on the boundary line west of Grand Portage.

323. The shores of the north side of this little lake are made of a chloritic quartz-schist, of a gray color, being much like one phase of that seen on Gunflint lake, passing to massive (310). This is laminated, seamed and disturbed, but the schistose structure stands nearly vertical, like that on Gunflint Lake, and yet slopes to the south 50° E. in general. It also contains cubes of pyrite.

From the tops of the hills at this place the country is seen to be very rough, presenting a forbidding, inhospitable aspect. It is rocky and burnt off on each side of the boundary, as far as the eye can discern.

The descent by portage into Otter-Track Lake is 40 feet, making Otter-Track Lake 874 feet above Lake Superior.

324. Near the portage, on the U. S. side is a more compact and massive homogeneous condition of No. 323. It is fine-grained, coarsely jointed, of a light green color, and in making this portage the trail passes over the same variation of this rock as that represented by No. 311, on the north shore of Gunflint Lake. Hence this seems to be a recurrence of that formation.

In passing along the south shore of Otter-Track Lake (which is narrow, and about 5 miles long, running S. W.), this formation is sometimes seen to be evenly bedded, and dips at a much less angle (say 10 degrees), toward the south.

The rocks in general along the boundary are smoothed and rounded, the marks of glaciation usually being indistinct. At the Otter-Track Lake the movement seems to have been toward the S. W. in the direction of the valley. The absence of real drift materials

is remarkable. There is no clay, and but little of any transported drift of any kind visible. The moutonne-ed rocks rise in hillocks everywhere, and are bare, or thinly covered by recent vegetable mold. Along the lake shore are some strange boulders, but even there the bare glaciated surfaces often run down into the water of the lake. This is particularly true along the south shore of Otter-Track Lake, while the Canadian side is strewn with fallen rock, or is roughly broken according to the joints. The rock bluffs here rise from 10 to 100 feet on each side, the Canadian side being the lee side in the period of glaciation. The U. S. side received the greater friction. The formation dips about south, but different systems of joints cause it to separate in angular blocks, and almost to appear basaltic. No trap was seen between the west end of Gunflint Lake and Otter-Track Lake.

From Otter-Track Lake there is a descent of 4 feet to Knife Lake; the latter being 870 feet above Lake Superior.

325. A light-green, tough magnesian rock, perhaps can be designated a chloritic or serpentinous quartzyte. From the Huronian slate series at the E. end of Knife Lake. This series extends from where first noted, on the Oak Portage (from Saganaga Lake westward), to this place, at least. This number is an important one in the series, as it continues a good part of the distance from the east end of Knife Lake at least to the narrows of the same lake, (bet. Sec. 11 and 12). The rocks all have a greenish color, but are not always slaty. No. 325 is not slaty, and is essentially the same rock as No. 324.

326. Pyritiferous clay slate; 3 miles west of the narrows, on the north shore of Knife Lake, and about $\frac{3}{4}$ mile east of the portage to the next lake N. W. The pyrite cubes are generally about $\frac{1}{4}$ inch across.

There is a descent to the next or Maple-leaf Lake, of three feet by a portage going N. W. from Knife Lake; the portage being about $\frac{3}{4}$ mile.

327. At the beginning of the last portage the rock of the slates varies to a blue-black, fine-grained siliceous rock, approaching flint in hardness and compactness, with conchiodal fracture, and sharp edges; sometimes it is nearly black. It is this sharp-edged rock that gave name to *Knife* Lake. It is only local, or in beds, or sometimes in ridges.

From Maple Leaf Lake the next portage ascends six feet to another lake, being a portage of about 15 rods.

328. At the beginning of the last portage; a clay slate; sometimes

argillyte; standing vertical and running W 30° S. The river from the last lake (near the portage), runs out over this rock in a sort of cascade or fall, the descent being 34 feet, to Sucker Lake, (or Carp).

The size of these lakes is often a surprise to the traveler. They expand unexpectedly, where the prospect is entirely shut off. They are shaped by the geological features. They lie between ridges of the Huronian, and these ridges run approximately E. and W. Sometimes a narrow opening in one ridge allows the lake to spread. Then it enters another narrow valley, and runs in it visibly a couple of miles, when it may jog back again into the former valley by another opening. Only one acquainted could follow the boundary line canoe-route. Sometimes entering a lake it appears small, but on reaching its visible western extremity it turns by a narrow channel and spreads out a couple of miles further west. The portages are short.

The roofing slates (like No. 326), seems to run westwardly, as the last portage goes, to Sucker Lake, and appear again at the Sucker Lake landing. The glaciation along here was to the S. W.

From Sucker Lake the portage to Basswood Lake descends 45 feet, making Basswood Lake 792 feet above Lake Superior. A river of considerable volume reaches Basswood Lake from the south near the point where the portage strikes it, said to come from Sucker Lake. A considerable river from the south enters Sucker Lake about a mile east of Basswood Lake. The beach, at the portage landing from Sucker Lake, is of granite pebbles and sand, but the rock of the country is yet of the Huronian, viz:

329. Dark green massive serpentinous rock, east end of Basswood Lake.

330. Three quarters of a mile N. W. of the point where the portage trail reaches the lake, on the United States side, is an exposure of choloritic gneiss, consisting of quartz, feldspar and clorite, and having a granulated texture, varying to a syenite. The gneissic structure dips about 30° to the west, 20° north. The most of the valley of the lake, to this point, is probably in this rock. The shores of the lake and of the islands are of stones of this gneiss, and are not generally rocky; thus being in great contrast with the shores of the lakes in the Huronian belt farther east, which are almost constantly rocky.

About ¾ mile further, after turning S. W., several points on the south shore show similar rock, but the schistose structure dips, in one case N. W., and in the next nearly south. Again, perhaps a

mile further, on an island it dips N. This schistose structure is really a bedding, the beds being about 3–4 inches thick.

331. The rock of the country at Basswood Lake, taken from an island two miles N. W. of the eastern extremity. It is white syenite or "granite". At 2½ miles further it is seen dipping N. W. Again about 2 miles further, after passing the narrows, it still dips N. W. This is at an abandoned post of the Hudson's Bay Company, and opposite a similar station on the U. S. side, the passage between, where the boundary line runs, being only about thirty rods across. The same dip may be seen at other points along here, and in the vicinity of other abandoned posts. The construction of the "Dawson route", and the destruction of fur animals, mainly by forest fires, have diverted and diminished such trading. Before passing all the trading posts the gneissic syenite becomes nearly level, and there shows a slight dip to the S. E. This gneissic structure is very regular, the layers being from two to four inches thick.

Making a portage on this trail to Pipestone Rapids the route crosses an arm of the north shore, which in low water is generally passed by following the lake round by the south. This portage is about 1½ mile S. W. from the trading posts, there being several islands intervening. The portage is short, and at its western end is an interesting series of exposures of rock, exhibiting the interstratification of mica schist (335) with gniess and syenite (336 and 337)—the concordant dip continues from one to the other, showing they are all of one formation and conformable, or that, if of different ages, the Huronian is conformable with the Laurentian. The shore line runs N. 30° E., and S. 30° W., and there is a high dip to the beds towards the south, about 80 or 85 degrees.

332. Near the portage landing, west end, in a low exposure; a fine chloritic (?) gneiss, the bedded structure sloping S. at a high angle.

333. Hornblendic schist, overlying No. 332, an interval hid, being between them; containing also chlorite.

334. Chloritic hornblende schist, conformable with No. 333.

335. Biotite mica schist, separated from No. 334 by a recurrence of rock like No. 332, conformable in dip with the last. This includes irregularly shaped masses or agglomerations of Nos. 336 and 337; also has thin, irregular, interrupted and contorted interlaminations of the same. They are certainly interstratified.

336. Biotite (?) hornblendic gneiss, of a light gray color, al-

ternating along the beach two or three times conformably with No. 335.

337. Similar to No. 336, probably one of its modifications, having more hornblende.

338. Compact, similar to the last, but darker colored; has beds or belts of No. 335, and finally is wholly replaced at the shore line by No. 335 for a short interval, while No. 338 is still visible inland a few rods, in the bearing of the strike, showing a change from one to the other in the direction of the bedding, as well as transverse to it. But a short distance further south the shore is wholly made by No. 338, rising higher, in coarsely jointed and firm, low hills.

339. Hornblendic schist, from the shore of the same lagoon, on the north side, where the same interstratified condition of the same kinds of rocks appears again.

339. B. From the shore near No. 337 and 338, not in place, but supposed to be from these beds.

340. A little further west from No. 339, on the north side of this little water, the rock appears as a micaceous quartzyte. which also varies to

341. A blackish quartzyte (?). somewhat micaceous in some of the interlaminations; which varies. a little further along, in some of its interlaminations to

342. A gneissoid quartzyte, and makes a high bluff, the beds in all cases dipping to the south. Then the rock is hid to the next portage (going to another bay of Basswood Lake, westward).

343. But just where this portage begins the rock forms a conspicuous outcrop of fine syenite, represented by this number.

These numbers (335, 336, 337, 339, 340 and 341) make up the islands and occasional exposures across this bay, but the most is of No. 335*. The portage from this lagoon, in which the above numbers occur, is across an arm of the mainland from the south shore, which is sometimes avoided by passing by water farther to the north.

344. At the other end of this portage, and at one or two spots on the trail, the rock is a tough mica schist. This here also embraces strips of syenite and of quartz. These appear mainly as interlaminations, but also as veins crossing the laminations.

345. The rock along the shore. passing up this long bay, is syenite, but the sample of this number is taken from the place where

*A similar interstratification of mica schist and granite is described in Ludlow's Reconnoissance of the Black Hills, in 1874 p. 44-45

the first view is presented up the long bay S. W. Hereit is evenly bedded, dipping W. and is of pinkish or flesh color. This continues past one or two small points, when it is seen to dip in the opposite direction. Then on the next it dips again southwest. The surfaces weathered have when smoothed a pink tint.

Further on the bedding is contorted, (along the south coast of of this bay,) and confused, appearing almost perpendicular in short intervals, then dipping again one way or the other. Just beyond this confused place the mica schists, &c., come in again, the beds being almost vertical (i. e. the schistose structure) yet sloping a little to the S. W. This is perhaps a mile from where the route enters this bay. This then continues, presenting the variations already described, to micaceous quartzyte &c., and having at least two systems of joints, one perpendicular to the schistose structure. and one cutting it obliquely, sloping N. W.

346. Passing to the north side of this bay, within a half mile, or perhaps more, the whole changes to a fine, tough gneiss, which has a coarse schistose structure that makes it resemble the schists. being probably only a variation of the schists.

347, A little further along, across the bay, the syenite returns: but here a schistose structure can be seen on weathering, parallel to that seen all along. This forms the coast for some distance on the N. side, at least to within ½ mile of the next portage.

Before reaching the portage a ridge of schists and fine grained chloritic rock appears along the south side, as the bay narrows up, presenting a columnar. or finely-jointed structure, somewhat resembling the basaltic.

348. This is mainly a tough, greenish schist, crushing under the hammer like a chloritic schist, apparently having a dip toward the south, nearly perpendicular, but so broken by jointage planes in different directions, and confused by the schistose structure, that it is exceedingly uncertain. This rock forms the lower rapids at the mouth of Pipestone R. where the water comes down to the level of Basswood Lake, the fall being 10 feet from where the rapids begin, to the level of the lake*.

Near the foot of the rapids a white quartz vein crosses the river diagonally, running about east and west, but somewhat zigzag. It dips at an angle of about 45 degrees from the horizon toward the south, and is about 5 feet wide. No gold or other mineral can be seen in it, except some pyrites in the grayish rock adjacent

*Mr. Robert Bell questions the existence of Basswood about this lake, and suggests *Whitewood* as a more proper name; but the real Basswood grows at the mouth of this river, being the most northern known limit of that species in the state.

to it on the south side. The formation above the rapids is about the same as below, but here it becomes the *pipestone* of this locality. It is simply a schistose, greenish, chloritic (?) rock, being a chloritic (?) slate at a short distance further up the river.

349. Pipestone, from Pipestone Rapids, a chloritic rock; not much worked nor used.

350. Chloritic (?) slate, from Pipestone Rapids, just above the pipestone rock. This slate stands nearly vertical but dips to the south.

351. About ¾ mile above the rapids the slates dip northwest.

This country contains much pine, but not generally very large. Indeed, the forest is all pine. The same is true along the south shore of the lake before reaching the river. Between the first and second rapids the river expands so as to be more like a lake, without current, and embracing several islands. The lake above the second rapids is known as Kawasachong Lake, and is 8 feet above the water below, or 810 feet over Lake Superior.

352. At the upper end of the second rapids, or a little distance above, near the portage landing, is a white quartz vein in this chloritic rock that makes the rapids. This runs S. 30° W., and coincides with the slate in dip, which is toward the N. W. This quartz embraces rusted pyrite, and has an auriferous aspect.

353. Slate, soft, greenish (talcose or chloritic), from about two miles further up the lake, on the south side. There is not much exposure, but sufficient to show the formation extends to here, at least.

354. A less slaty chloritic slate, from the same place. The slates here run S. 30° W., standing nearly vertical, sloping south. Indeed this direction is about that of the narrow long lake in which the route lies.

The forest along here is not exclusively one of pine, but much white pine of good size is scattered all through it. The country is generally slightly undulating, but not hilly, being much in contrast with that east of Baswood lake. There are low ridges of this slate that cross the country, but they hardly produce a perceptible change in the general surface features.

355. At about a mile further, on the same side, a more massive and siliceous slate appears, showing, also, some white quartz veins. This is probably a variation of the slate, and is exposed but a short distance. The beaches are sandy along here.

A short distance further west the Kawasachong river enters Kawasachong Lake. This river comes from Birch Lake, and

along it is a canoe route to Beaver Bay, on Lake Superior. Birch Lake is the third lake south of Kawasachong Lake by this route. The maps generally represent this river as entering several miles too far east.

The Kawasochong falls are visible from the lake. They descend about 40 feet—split and straggling in low water. Here is a large exposure of the same rock as No. 355, but less siliceous, which really appears to be the same as the "pipestone" at Pipestone Rapids. It also contains here narrow white quartz veins and deposits, and some two or three feet wide. One such appears in the river, just below the falls. The falls are within 30 rods of the lake, and the river is one of good size. This rock is neither bedded, jointed nor schistose, but it breaks with a very coarsely schistose manner, and each piece runs to blunt points lenticularly. Chlorite permeates and colors it. It seems to be closely seamed in all directions, but not with any regularity, if we except the general schistoid fracture, which coincides with the slates in being nearly perpendicular, and yet in sloping to the south. It abounds in (talcose? or) chloritic and hæmatitic slickensides. It is everywhere rough, superficially, and mashes under the hammer before breaking, and then breaks toughly.

356. Rock from the Kawasachong Falls on Kawasachong River. The same rock appears on the lake shore at points further west.

At the next point, ¾ mile from the mouth of the river, it appears again more like No. 355.

At the next, 1¼ miles from the river, it is the same.

At the next, nearly 1½ mile from the mouth of the river, it is more like No. 356.

The same or similar rock, at least the Huronian slates, etc., continue to the end of this lake, when a portage is made to another lake, avoiding the river on account of very low water, following the "winter trail," which sets out from another arm of the lake further toward the north.

357. Occurs just at the point of the beginning of the "winter trail" from Kawasachong Lake westward; a chloritic slate, running nearly S. W. and sloping to the S. E. This portage ascends 80 feet and descends 17 feet leading to Long Lake, which is thus 873 feet above Lake Superior. On this portage, in its eastern half, are several outcrops of slate like that already noted at Kawasachong Lake, but mainly the country is drift-covered with less rock exposure. Along north of this portage (which is about 1¾ miles long) is a

hilly range running nearly parallel with Long Lake and also with Kawasachong Lake, which appears to be of the Huronian, judged by exposures that are seen along the lake shores. There is still considerable pine in the forest, especially on the south side, the north side being more burnt.

358. Chloritic or serpentinous rock from an island near the west end of Long Lake; continuation of the same formation as at Kawasachong Falls.

The country at the west and northwest end of Long Lake is more rough and has more exposures of rock. It is likewise more burnt.

From Long Lake the course of travel by canoe is up a river toward the west, perhaps a mile (in a right line), then up a tributary, turning to the right; then after ½ mile further, a portage (½ mile) is made to Burnside Lake, 904 feet above Lake Superior. This portage in general goes N. of W. and over a part of the ridge of hills mentioned as running along the north side of Long Lake. The rock in these hills where crossed by the portage trail is a tough, chloritic rock, viz:

359. Firm, tough, chloritic rock; perhaps a fine-grained protogine from the hill-range running on the north side of Long and Kawasachong Lakes, on the portage from Long Lake to Burnside Lake. This rock at a distance appears gray and granite-like under the weather.

Near the west end of the portage trail, on Burnside Lake,* within an area of 30 feet square, the following numbers, from 360 to 367, both inclusive, were obtained, Nos. 360 and 361 comprising the bulk of the rock.

360. Greenish-gray fibrous hornblende rock, somewhat serpentinous or chloritic.

361. Dark-gray hornblendic rock, chloritic.

362, Glistening chloritic schist.

363. Hornblende schist, chloritic.

364. Granular rock, consisting of hornblende and imperfectly crystalline orthoclase.

365. The same, with quartz and chlorite. The disintegration of this orthoclase produces sandy beaches sometimes about these lakes.

366. The same, with less hornblende, and a reddish color in the orthoclase (?).

367. White, glassy quartz, becoming colored red by hæmatite.

*This name is a corrupt translation of the Indian word signifying *Burnt-side*.

These numbers are all arranged in a crooked lamination or coarse schistose structure, parallel with the same seen in the slates about here. The hornblende schist (No. 363), and the hornblende and feldspar rock (No. 364) gradually interchange, or pass onward to Nos. 365 and 366. Large masses in knolls and hills lie in the immediate neighborhood, made up of the same rocks.

But further west, on the same side of the lake, the hills are more of the nature of No. 365, yet are in the same way associated with hornblende rock and schist, viz:

368. Chloritic syenite. North side of Burnside Lake.

369. Flesh-colored chloritic gneiss. A vein or layer in No. 370.

370. Chloritic gray quartzyte, compact and hard.

The foregoing are all (359–370) conformable, when they show any stratification at all, which is always the case except when there is a full transition from No. 363 or 364, or even from 360, to No. 368. In that case, when No. 368 is fairly set in the parallel structure, always dipping at a high angle to the south (or a little east), becomes more and more indistinct, or is lost, and in its place a jointage running in different directions, hardly ever parallel with the schists, is substituted. Yet even then, in some weathered situations, a natural parting of the rock brings out a rude schistose structure parallel with that in the slates. It is impossible here to state whether these alternations of rock indicate a coming on of the Laurentian, conformably interstratified with the Huronian, or that the syenite is all in the Huronian. The line of travel through here is nearly in the strike of the Huronian, but has been (since leaving Long Lake) a little to the north, so that if this be a beginning of the Laurentian it comes on, in accordance with the dip, conformably. This series of rocks apparently runs along the north side of Long Lake, some distance from the shore.

The islands and the aspect of the coast and the country about Burnside Lake, traveling on a line a little west of south, appear like those of Saganaga Lake. The islands are nearly as numerous. The rock however is of this transition series of hornblende schists and syenites. The veins of syenite are sometimes white and sometimes reddish, and are often contorted in the schists. They project above the surface, reminding one of the chain coral in the Lower Silurian limestone. The syenite weathers reddish along the lake shore, but the schists do not.

Through Long Lake the glaciation runs S. W., or in the same direction as in Otter-Track Lake. About Burnside Lake, although

the rocks are all domed, there is little evidence of the direction of movement. The islands are of bare rock, especially at the west end.

There are places along Burnside Lake, toward the west end, where no bedding nor dip can be discerned, even in the hornblendic rocks, but the whole is disturbed and confused by jointing. But near the river where the route leaves the lake westward, the bedding appears running more south and dipping at a high angle N. W.

371. At the mouth of this river leaving Burnside Lake.

372. At the same place.

These are almost an exact repetition of Nos. 369 and 370, except that No. 372 is more syenitic. Ridges and knolls of this rock here rise fifty feet or more above the lake. Ascending this river about a mile, a portage is then made of another mile to Mud Lake, the whole ascent being 14 feet, or to 918 feet above Lake Superior.

Along Mud Lake the same series of rock continues.

373. Clay slate. From the N. E. end of Mud Lake.

374. Clayey quartzyte (?). From the N. E. end of Mud Lake.

These are from the N. W. side of Mud Lake, in close approximation. The schistose or slaty structure is apparent here, and runs south 30° W., nearly vertical.

375. A quartz or chloritic schist. Mud Lake, at a point a little further S. W, from No. 374, when the lake turns more to the south.

About half a mile further S. W. an old mining location can be seen.

376. From the old mining location on Mud Lake. The rock here is like that of No. 375, but perhaps more compact. It is pyritiferous. It has a gray color, with mottlings of light green and glassy grains of quartz. It is firm and hard, the greenish parts being apparently amorphous with a hardness about 4.

The vein matter here was apparently wholly exhausted by the mining operations. It was a lenticular mass about 20 feet long, and not probably over 12 inches thick, tapering up and down in conformability with the rock enclosing it, and running also in the same direction. The white quartz here mined is apparently the same as that disseminated through the rock, but in larger local abundance.

377. Vein matter, quartz and ore, from Mud Lake. This ore contains plainly chalcopyrite, pyrite and galenite, and probably gold.

378. Quartzitic slate, with talcose partings; from about half a mile further after descending a shallow river-lagoon.

This river is thence followed S. W. to Vermilion Lake, the fall being about 9 feet, making Vermilion Lake about 909 feet above Lake Superior.

379. Chloritic schist from the N. E. end of Vermilion Lake, where the stream from Mud Lake enters it. This rock is like that in a range of hills which continues all the way to Mud Lake, along the north side of this stream, apparently confining the stream on that side, the slates running W. S. W. at Vermilion Lake.

Round Burnside and Mud Lakes, and at the N. E. end of Vermilion Lake the Huronian is rougher, and considerably more denuded, the ridges being higher. At the same time there is no diminution in the drift.

380. Vermilion Lake, at one mile S. W. from the mouth of the stream from Mud Lake; a massive chloritic syenite.

381. The next point S. W. along the S. E. shore of Vermilion Lake, shows a gray horn blendic (?) rock, jointed and with white quartz veins, or deposits in the joints.

382. White quartz, from a vein on S. E. side of Vermilion Lake, running in No. 381. This is a conspicuous white quartz belt, running up from near the water level, a little S. W. from the last point, being a local and irregular deposit, not having much depth. It splits. It stands above the surface nearly a foot. It holds chalcopyrite, which superficially has colors like bornite. It is about 3 ft. thick, and has been dug through by some "prospector."

The schistose structure along here runs but little S. of W. It is indistinct, on account of the rock becoming massive, or only jointed.

Passing a long arm or bay, running a little N. of E. the rock on the first point south of this bay is

383. A gneissic and feldspathic chloritic, gray quartzyte. The schistose structure runs a little S. of W. and is hardly discernible. There is a close jointage that appears here, and at other points, that closely resembles the schistose structure when it becomes slaty, transverse, (nearly at right angles) to the schistose structure. This is plainly a jointage simply, and not anything that affects the tissue, as when a specimen be broken, it breaks with the schistose structure, parallel with it; and if it be from between two planes, or has a joint on two sides, it will persistently remain triangular although it be broken till reduced to too small a size for preservation.

384. Half a mile further along, the schistose structure plainly returns and is W. S. W. and also the chloritic or talcose character. This number is a talcose (?) and at the same time a schistose quartzyte, with considerable greenish-gray, amorphous, feldspathic (?) mineral, and seems to be allied to the rock No. 311, on the north side of Gunflint Lake.

This part of Vermilion Lake is filled with rocky islands.

385. About a mile a little west of south from the last, on a point; a dark colored siliceous slate, or hornstone, mainly in regular and thin sheets, but in some places confused, the slates running W. S. W. and sloping to the south, but nearly perpendicular.

386. On a small island near the S. E. shore; rock like No. 384. Here the schistose structure, sloping S. E. runs S. 50° W. by compass,* and is sometimes a little wavy. In these descriptions *slaty* and *schistose* express variations only, of the same structure.

387. About a mile S. W. of the last the rock varies to a schistose, chloritic syenite, of a light gray color. This is apparently only a variation in the ingredients of No. 386. It is a firm rock, and at a distance appears like massive granite or syenite; yet along the lake shore it parts in a gneissoid manner. It rises higher than the adjacent hills, and is coarsely jointed, so that its rhomboidal parts rise like whitened sheeps' backs. It extends perhaps 20 rods.

388. Half a mile further west the rock is a gray quartzyte, with much white quartz in veins and joints.

389. A mile further west, and near the entrance to the bay that leads to the portage going south from Vermilion Lake to Squagemaw Lakes, the rock of this number which is a gray chloritic schist, is seen to have a nearly east and west slaty structure, varying to a little S. of W. This slaty structure is intersected diagonally by alternations in the rock due to sedimentation, running nearly N. W. and S. E. The kinds of rock exhibited by this alternation are as follows. from No. 389 to No. 394 both inclusive, the former being on the N. E. side and the latter on the S. W. side.

390. Chloritic slate, greenish, soft.

391. Pyritiferous, gray, quartzyte, chloritic.

392. Argillyte, or clay slate.

393. Chloritic gneiss.

394. Siliceous, chloritic slate.

Glaciation across these beds runs N. and S.

*Magnetic directions in this report are all *by compass*.

At the Government Station, where the Indians are taught to do some farming, which is a little N. of W. from the last point, the New York Mining Company formerly sought gold in the quartz and talcose (?) rock of the country.

395. Fine, soft, hydro-mica slate. This rock has generally been denominated talcose slate. and it may be correctly. This will have to be determined by laboratory examinations. This is from the N. Y. Company's location, at the Government's Station, and the slates run 15° S. of W., and glacial marks 10° W. of S. The strike of the stratification, as mentioned under No. 389, is E. and W., the slates crossing the strata diagonally.

396. "Gold" quartz, from the above mining location. This is white. It is scattered in the joints and irregular veinings in No. 395, similar to what may be seen in many places about Vermilion Lake. (See Report for 1878, p. 28.)

397. The Minnesota Company's location was about three miles north of the Government's Station, on the west coast of a lake, opposite the long point projecting from the N. shore. Here the rock is a coarse chloritic slate, having a close relationship with that of No. 395. The slaty structure runs about E. and W., and glaciation about N. and S., or a trifle east of south.

398. The quartz from this mining location, occurs in the joints of the rock, in irregular deposits, but generally coincident with the slatiness. It carries considerable pyrite, which is also scattered through the slates.

399. Talcose (?) slate, from Simond's location. This is farthest N. W. (or W.) and about four miles from the outlet of the lake; and between this and the Minnesota Company's location was that of Nobles, numerous islands occurring all along. This number represents the country rock. It is siliceous, and contains scattered nests, or broken layers of white quartz, both coincident with the slates and in the diagonal jointage. Pyrite is scattered through the quartz, and through the slates, and particularly in a line of contact where they unite, the quartz becoming gray.

400. Quartz from the same point.

401. Near the western extremity of a point or peninsula that comes near the south shore from the north. A little island here shows rock like that on the north side of Burnside Lake; a mica schist. This is arranged in laminations that run S. 55° W., sloping S., and embraces laminations and wide belts, also conformable with the rest (except where large areas come in) of

402. Syenitic gneiss (and of quartzyte); also

403. Micaceous hornblende rock, apparently hornblendic syenite.

Where No. 402 occurs in large areas its boundary is not always parallel with the schists, but jogs across a foot or two of them and then runs again parallel, sometimes also crowding them confusedly. This is on the island nearest the point at the narrow passage for canoes bound west. The extremity of the point is of the same character of rock, but the change from the talcose (?) to mica slate or schist is very gradual and imperceptible, the colors and characters blending and mixing apparently in the same rock. At the same time the quartz interlaminations and deposits of the talcose (?) slates, mined for gold, become syenite in the mica schists (with fewer quartz veins).

Further north, perhaps a mile, the syenite runs both obliquely across the schists, in sharply defined veins, and also nearly coincident with them. In one case a belt curves round from one system to the other. There is also in the schists a net work of harder, more quartzose rock, which crosses itself both finely and coarsely, and becomes evident on the weathering of the formation along the water line. The schists here also contain fine crystals of pyrite.

404. About a mile and a half further northwest, up a deep bay, is a ridge of granite, massive and jointed, not laminated or schistose. This is on a point of the N. shore.

405. A few rods further a ridge of this rock appears. This is firm mica schist, with reticulations and interlaminations of gray quartzite and quartz, and also cross layers and interlaminations of syenite. In the main the syenite is coincident with the schistose structure. In this locality are many islands, made up apparantly of rock like No. 405, north of which is a large bay running far west. North from the last point on the north side of this bay, the mica schists again are seen, of the same kind as the last, but the structure and laminations all dip to the north (a trifle east) at an angle of about 30° from the horizon.

406. Mica schist from the north side of this long bay (as above noted) with included gneiss, on the north shore of Vermilion lake.

407. A micaceous quartz, from near the same point.

This coast is bold and more rocky, running NE. The dip and character of the last continue northeastward past several points, the rock becoming more granitoid.

408. Fairly represents the whole of the exposure, a confused granitoid rock, with patches of mica schist.

409. Granite. On the next little point, which encloses (on the E.) a deep, narrow bay running N. to the outlet of Vermilion L. is an exposure of gneiss which passes confusedly to granite and to mica schist, but has no schistose structure. It appears as if a very coarse conglomerate might have been brecciated and then metamorphosed. There are small patches of mica schist surrounded by gneiss, and bands of coarse granite running through the whole varying to a fine granite, and so to a micaceous quartzyte. It is smooth, massive and bare.

410. Granite ; same place as No. 409—pinkish.

411. Granite ; same place as No. 409—pinkish.

412. Mica schist ; same place as No. 409.

413. Mica schist, from the Vermilion rapids, at the outlet of Vermilion Lake northward.

At the outlet, which leaves the lake northwardly, and which seems to be in the northwestern part of the lake, the water goes down about 50 feet, with considerable tumult, over large boulders of coarse granite, without much exposing the underlying rock *in situ* along the river. But by the freshness of slabs of mica schist, and their size, it may be inferred that the rock under the rapids is No. 413, and on the east side of the bay from which the river goes the same rock as No. 413 can be seen *in situ*.

Eastward from the Outlet bay the rock soon appears, and is a coarse granite, viz :

414. Granite, with a little mica schist in spots.

415. Mica schist, embraced in No. 414 ; north shore of Vermilion Lake. The same (granite and mica schist) continue round the deep bay running east, and along the south shore of the same, so far as the few exposures allow a judgment to be formed, and on the point where the shore finally turns south again, the rock is also mica schist, enclosing patches of coarsely crystalline granite, the whole dipping N.

416. Mica schist, from long point on the N. shore of Vermilion Lake, east of the outlet; varying to

417. Micaceous quartzyte.

This long broad point, which extends southwardly, leads to the location of No. 404 and No. 405. The mica schist, with associated granite (or No. 404) occupies the N. shore all the way round. It is not yet possible to say whether these granite and syenite

areas are embraced in the Huronian or indicate a conformable approach to the Laurentian.

418. At about a mile S. E. from the location of No. 404 and No. 405, on the north shore of the lake, but on the south shore of this long broad point, on the N. side of a bay, is seen this fine granite, and

419. Micaceous quartzyte. These are about equally divided in making a rocky point, and have a schistose structure running S. 15° W., nearly vertical. The point is high, firm and bare, the schist being knit by reticulations of harder quartzyte, and by bands of granite, so as to resist disintegration.

There are several other outcrops of similar rocks on this long point, as far as to and beyond a long bay running S. W. This bay along the south coast is rocky, and is made up of mica schist with reticulations; but it is softer, finer and apparently approximating a talcose (?) character. Glaciation here runs S. 30° W. and the slates run in about the same direction: represented by

420. Soft mica schist.

421. As this "north shore" begins to turn east, the coast is high and rocky. This is after passing the narrow canoe passage mentioned under No. 403, and S. E. from Simond's location about a mile. There is a prominent system of joints dipping N. and not an evident schistose structure. The veins and joints are either white quartz (some has been worked slightly) or are quartzitic. The reticulations mentioned as seen in the mica schist are much less distinct, or are wanting. The rock is

422. A talcose (?) quartzyte.

Three-fourths of a mile further east this rock, No. 422, shows a schistose structure running W. S. W. and sloping to the south (or S. E.) The slabs, sliding off according to the joints, hide from first view this structure, and also make the immediate shore precipitous.

423. Ore from Nobles' mining location; Vermilion Lake. This is about a mile N. W. from the Minnesota Company's location, and on the south side of a long point extending S. E. from the west shore, and on the north side of the included bay. The rock is a chloritic (or talcose) (?) slate, varying to a greenish schistose quartzyte. It has pyrite crystals scattered through one or two narrow quartz veins (each 1 to 4 inches) and also through much of the siliceous rock itself. The frame of their mill still stands, and two large reverberatory furnaces, amid the ruins of other ma-

chinery. The stamps were five, made in Chicago. In this mill much of the country rock was crushed as well as the quartz.

424. Chloritic schist: from a little west of the Minnesota Co.'s location. The structure here runs W. S. W. and slopes a little north. Also at other points between this point and Nobles' the structure slopes N. This number is only a local variation in the prevailing slates of the region, extending only about 6 feet.

425. Pyritiferous granulyte, (quartz and feldspar) and blue scales from some of its joints. This rock forms a low island in a large bay west of the Government's Station, or that principal part of Vermilion Lake which is next west of the Station, and is shut in on the north by a long promontory-like point with drift boulders and sand on the immediate coast, along the S. E. side. The island is near the head of this bay, about two miles from the station. The rock is jointed and somewhat schistose coarsely, in about the same direction as the slates here, and slopes N. It seems to be a part of the slate formation; but there is not sufficient exposure south and east of this point to make it certain.

426. The rock of Ely Island or its variations. Much of it is like No. 311 and No. 375, perhaps the greater part. It is mostly of a light color, often with a light green tint, having free quartz in a matrix generally amorphous but yet presenting a fibrous or broken schistose texture; passing to a porphyritic rock (with albite crystals) (?) and to a pyritiferous syenite. On the north side of Ely Island is to be seen a conspicuous white quartz lead, or vein, about thirty inches thick, sloping about 55° from the horizon to the north, distant from the west end of the island about a mile. It rises so as to make one of the highest parts of the island. Some working for gold has been done on this quartz, near the lake. The quartz itself is barren, but the adjoining rock is pyritiferous, like nearly all the rock about. It has a structure dipping north, the same as the lead of quartz, and is jointed in all directions.

On the north slope of Ely Island glaciation shows S. 8° W., and on the top of the island it is very coarse and in the same direction.

In traveling over the island, where much of the rock is bare, occasionally may be noticed bright red pieces of jasper superficially embraced in the formation, some of them three or four inches across. The position and structure of these pieces is at variance with the schistose structure of the rock in which they are embraced. They at once recall the "gunflint beds," which at Gunflint Lake first overlie a similar greenish and magnesian formation, having a slaty and a schistose structure like that seen here. These

pieces seem here to be relics of that formation, which once must have extended over Ely Island, but now is unknown about the immediate shores of Vermilion Lake. The quartzyte (and gunflint series) underlying the lowest igneous overflow of that age, was probably so thin that the heat so softened the underlying (Huronian?) schists that some of the more siliceous and less fusible parts of the gunflint beds were cemented into the schistose, and after the erosions of the glacial epoch they still are seen so embraced. This heat produced a second metamorphoism of the magnesian formation also, changing it locally, apparently, to a phonolitic, or porphyritic, partially crystalline rock. Some of these relics, still attached, are conglomeritic; and one area, which is embraced in a depression in the upper surface of the schists, is over two feet long and eight inches wide. Loose pieces, pertaining to the drift, may be seen on the top of the island, being of black quartzyte, showing that the quartzyte formation must have extended once to Ely Island at least, since the movement of the drift was from the N. and E. of N. It may also have extended further north, and probably did, at some pre-glacial time. These jaspery pieces, generally smaller than a butternut, but sometimes as large as one's fist, are nearly always angular, or but little rounded, and are in some portions thickly sprinkled over the surface of the schists.

There is a high hill-range to the south of Vermilion Lake, about a mile and a half from the shore, which may be the beginning of the trap and quartzyte range again. That would be in conformity with the foregoing hypothesis. Indeed these hills appear to be of some rock different from the rock along the south shore of Vermilion Lake, as they do not appear white at a distance, like the immediate shore of the lake, though the timber is wholly burnt from both.

427. Rock of Ely Island, containing jaspery pieces.

428. Pyritiferous quartzyte, from Rison's place, Ely Island.

Passing about a mile up a river running into the south part of Vermilion Lake from the east, about two miles from the entrance of Pike river, being the easterly of two rivers that enter the lake near together, and then traveling by a blind trail about ¾ mile toward Vermilion Lake, we reach an old iron-working, said to have been done by Stuntz and Mallmann, under the direction of Prof. A. N. Chester in 1872. This iron is in what has been denominated in these notes the *Gunflint beds*. It is in conformable arrangement with the magnesian schists and slates. Indeed the

Gunflint series here presents a good exposure. It stands in laminations and schistose bands nearly vertical, and is only a modified superficial condition of the underlying schists. These beds pass downward into the schists, and in places the schists and the schistose structure penetrate upward into the jasper and iron. The jasper and iron are in some places replaced by bands of white quartz. Here are all the beautiful variations between jasper and hæmatite, banded together, and quartz, which can be seen at Marquette.* Although the structure of these beds here seems to make them conformable with the underlying slates and schists, yet it may be this structure is only that superinduced on them at the same time that the schistose structure was formed in the schists, the original bedding (which may have been nearly horizontal) having been obliterated by the change. In the same manner, or in a similar manner, the bedding of the same formation has been seen to be destroyed by contact with metamorphosing agencies, as at places on Pigeon Point, and a very different aspect given to the formation. Further observation of this horizon is necessary to settle this question of conformability between these two formations. There are several knolls of the schists in this vicinity, capped with this iron and jasper. They run in the usual direction, a little south of west, and seem to be very persistent under glaciation, as they would naturally be. The belt must run northeastward toward Gunflint Lake, and is here, apparently, about a mile wide. The greatest thickness seen here is about 25 feet. There are gradations in the coloring of the qnartz nodules in this rock, some being gray, and some uncolored, while others are nearly black, and some vermilion red and jasper red. The name of the lake is supposed to have been derived from these colored pebbles.

429. Hæmatite from Vermilion Lake, as above.

430. Conditions of the silica from the same place.

About the southwest shores of Vermilion Lake, which expands right and left in broad sheets of water and in bays, that have a direction according to the trend of the geological structure, much more than is shown on any maps yet published; there is much drift, some of the points and narrow land-lines being of stratified sand, while along the coast in general can be seen only boulders.

Opposite Winston, the town site laid out by Maj. T. M. Newson, there is a firm gray quartzyte in outcrop. Several other small exposures of a laminated quartzyte, with a structure par-

*Boulders of the greenish schists occur on the south shore of Vermilion Lake, with bands of jasper running through them at least three feet from any outer surface.

allel with the slates of the country, occur before reaching the entrance to Pike river.

431. Rock that forms the first rapids of Pike river; three feet of gray, firm fine-grained, heavy crystalline rock, similar to some of the beds of the quartzyte and slate formation.

At the main rapids of Pike river, where the first portage occurs, there is a tumbling fall of six or eight feet, making a good water-power. This is about $\frac{1}{4}$ mile from the bay where the river enters, and here is a considerable exposure of rock, on each side of the river.

432. In general a gray quartzyte, but varying to a syenitic rock, and to a siliceous slate, and to white quartz, as well as to a tremolitic (?) mica schist, which is dark gray. It exhibits small faults, in which the otherwise parallel and regular strata, or laminations, are jagged or twisted, the west end moving southwardly about 5 inches or less. This rock, except in its perpendicular arrangement, and the absence of trap, resembles the gray quartzyte formation of Pigeon Point. It is more highly tilted, and generally metamorphic. The beds are nearly perpendicular, but dip to the south. If this be in the strike of the gray quartzyte and slate, the Vermilion iron-ore belt must pass north of here, running below the south arm of Vermilion Lake, or perhaps crossing Pike river north of the rapids. The structure of these beds is parallel with that seen at the iron beds at the location southeast of Vermilion Lake. Glaciation above the rapids is N. and S.

The river above the falls and rapids is 923 feet above Vermilion Lake, by aneroid, and above the third rapids is 938 feet, where the glaciation was S. 10° W. The rock at these third rapids is of the same gray quartzyte formation, the strata running E. and W., and dipping S. at an angle of about 60°. On another knoll the structure runs W. 25° N. This is also true just at the upper landing; in other places it is lost, the rock becoming massive, but having then a coarser grain. Where the structure is W. 25° N. the beds stand more nearly vertical. At a point on the left side, about a mile above the last portage, and before reaching the fourth rapids, there is an outcrop and a covered ridge of quartzyte, the beds of which are about 10° out of perpendicular, and dip to the north. Their edges run W. 5° N.

Two other rapids in Pike river, passed without portage, show no rock *in situ*, the water rolling over boulders, but at the first there is no doubt that the quartzyte from the ridge and outcrop last described closely underlies. A short portage is then soon made, at

the crossing of the "Vermilion road," the rapids here being styled "Devils gate rapids." Here also are only boulders, but from the size and frequency of large quartzyte masses, that rock is judged to be still underneath.

At a point judged to be about five miles from Vermilion Lake occurs a low irregular outcrop on the right bank of the river, represented by

433. A fine-grained reddish gneiss. This does not show certainly the direction of "bearing," but by its generally up and down fracture it seems to be allied to the quartzyte formation, as well as by its composition, the quartzyte formation sometimes passing into gneiss. This is highly inclined.

About 3 miles further begins a portage across a cranberry marsh about a mile over. The trail is covered with about two inches of water, and the river is but little lower.

The summit portage which leads to a stream flowing south (the Embarras) is over three miles long. It is a difficult portage, going over alternating sandy plains of Norway pine and wet tamarack or ericaceous bogs. In the swamps are laid small poles and sticks, which, if a person does not slip from, keep his feet out of the water and mud, but which from their insecurity to booted feet prove a great aggravation. It is mainly a flat country with a gradual descent to the south and occasional steps downward from plain to plain, the steps being boulder-strewn. There are also kames of gravel and sand. From the abundance of granite boulders, it is probable that the entire distance, from where the trail leaves Pike river to the Embarras, is occupied by one of the Laurentian belts, indicated also by the reverse dip seen at several points on the Pike river. It is really the Mesabi, or divide between streams flowing N. and S. though the great range is about two miles further south. At about a mile from the north end of this long portage, (which is drift-covered and generally dry to this point) occurs a dome of moutonne-ed syenite, viz.:

434. Syenite, with some of the feldspar flesh-colored, and some of it white. This is on the right of the trail, and spreads several rods round, rising 6 or 10 feet. This is about ¼ mile north of where the famed "Mesabi Hights" first appear in traveling south. From the north the "Hights" have an irregular contour, not like the quartzyte and trap range along the Boundary and Mountain and Rove lakes, but more like a great drift moraine. They rise several

*In passing this summit portage the shrub *Sweet Fern* is seen growing abundantly, on a gravel ridge or "kame".

hundred feet above the surrounding country. They may be superficially of drift, but probably their location, hight and composition are largely made by rocky barriers.*

The Embarras river is lake-like, for ¾ mile; then rapids, and ¾ mile portage, the descent being 64 feet, to a lake. Throughout this portage there is no rock *in situ*—only Laurentian boulders can be seen, and they are very numerous. The same is true along the river, except at one point where there is a visible bare rock, on the right bank of the same sort as the boulders, which is probably in place, viz:

435. A Laurentian syenite, like the rock No. 305, at the east end of Gunflint Lake, lying near the line of strike of the quartzyte and slate formation. This forms here the lower reaches of the Mesabi. The range seems to be of drift.

Along the east side of the next lake is high land, but no rock can be seen. About a mile from the north end of this lake is a high knoll on the west side of the lake, but there is no sign of rock. The whole country is deeply drifted. This feature steadily increases in going south after leaving the south end of Vermilion Lake. The course of travel seems to be mainly in the line of the great central glacier of this part of the State. The Embarras river here passes through one of its lateral moraines. This lake is about 5 miles long and averages ½ mile wide. At the foot of this lake is the "Squagemaw Bridge" where the Vermilion road from Duluth crosses the river.* This bridge is about on section 5, T. 58, 15.

From Squagemaw Bridge to Little Falls.

High land extends indefinitely, in the form of hills, along the west side of the Embarras river, southwestwardly from the Squagemaw bridge (Sec. 8, T. 58, 15). These hills seem to be made of drift, lying here on the Laurentian (No. 435), without apparent conformity or parallelism with any rock-range, the river crossing the drift-range about a mile above the bridge.

The road to the Mesabi iron location passes eastwardly from the bridge, through the northern tier of sections of T. 58, 15, revealing a very fine, level (burnt) tract of farming land, underlain by a coppercolored drift-clay. In section 31, of T. 59, 14, the drift clay is seen to contain a great many pieces of jaspery and quartzitic

*Squagemaw means "last lake," and the word applies to the second lake below this.

rock from the gunflint beds. On Sec. 28, of the same town, near the center of the section, some surface work has been done to develop the iron of this region. Some shallow pits have been sunk and one east and west trench dug, but none of these works seem to have reached the bed-rock. The drift here consists almost entirely of debris of the quartzyte and gunflint beds. Some pieces of pretty good hæmatite are also mixed with this debris. Near the section line between 15 and 14 is another pit, sunk alongside the faulted rock of the gunflint beds, the face of the bluff appearing above the ground and looking S. E. (A). The face then swings round so as to look south. The compass is exactly reversed by the proximity of magnetic oxide, glaciation being estimated at 20° W. of S. The ore here is closely associated with the rock, and they run together, and blend.

Almost due west from the foregoing, distant about half a mile, are several other trial pits, intended to show the trend and surface characters of the layers containing the iron, (B). Here the face of the break looks north, and the beds dip a little toward the south. The rock rises to the surface, and the needle is useless. The layers are about 3 or 4 inches thick, differing from (A), where the rock is massive or in heavy layers. Here seems to be a large amount of good iron, but it cannot be stated how far these characters extend without elaborate magnetic observations. The formation is the great quartzyte, probably near the bottom.

Along the road further northwest is another working (C), which is near the road, and marked by a high ridge of the iron-bearing rock running E. and W., and dipping nearly N. The upper part of this exposure is hardened and massive, and black. This is about 5 feet thick, as seen in the pit, and under it is a thickness of about 5 feet more of a loose limonitic mass. This is a conspicuous irony ridge, but its effect on the needle is not so great as at (A) and (B).

436. Ore from the Mesabi iron range, shaft (A.)

437. Associated rock at (A.) This is charged with siderite, and even becomes changed to siderite, as at Gunflint Lake.

438. Ore from the Mesabi iron range; shaft (B).

439. Rock associated; similar to No. 437.

440. Ore from the Mesabi iron range, shaft (C), near the bottom; somewhat limonitic and carbonated.

441. From the same shaft near the top.

About half a mile south of the last is a shallow pit dug for sil-

ver. This is in the gray quartzyte. The country rock is somewhat banded with iron.

442. Rock of the country: from the Mesabi iron range, from a shaft sunk for silver.

On this range of high land are considerable tracts of hard wood, with only scattering pines. The large trees are gray birch, elm, sugar maple, white birch, black ash. The white pine and white cedar creep in slowly along damp spots or slopes, and some large tracts are principally covered with pine, the trees being some of the largest seen in the State.

Other trial pits for iron were sunk in 1874 in T. 60 N. said to have promised even better than the foregoing in town 59.

Between the second and third lakes of Embarras River there is a rapid, and a descent of about 15 feet, making it necessary to portage about 20 rods. This makes a fine water-power, and is well situated for a lumber mill. No bed-rock is visible—only boulders.

The country has but little grown timber, what there is being scattered Norway pine. The whole surface for many miles in all directions appears to have been devastated several times by fire during the last 15 years. Hence there is a small growth of aspen almost everywhere, varying in age from one to a dozen years. This lake is small, and the river goes by a similar rapid into the 4th lake of Embarras River, with a descent of about 8 feet in 10 rods. This lake is separated by narrows like a river into two parts, and finally passes into the real Squagemaw Lake (last lake) at the head of which is a sandy beach, the portage to which is about 30 rods. This lake is larger than either of the last two. Below this lake the river has a considerable volume and current, and often sandy banks, the country also being flat and sandy, with generally small timber, mixed pine and hardwood, but many aspens and birches.

White oak was first seen at Squagemaw Lake. There is no bur oak in this country, so far as can be seen in traveling this route, but various maples, ash and elm are common, also bass. The balm of gilead is not a common tree. It seems to prefer the lake shores. The land is generally dry (to town 56, 17), at least so far as can be seen from the river, with occasionally an exposure of drift-clay, affording small stones. The rapids along the stream show only bowlders, there being apparently a heavy deposit of copper-colored drift-clay over which the river runs.

Passing down the St. Louis river to the mouth of the Big Whiteface river, the drift, which everywhere is thick and hides the rock

from sight, can be summarized, so far as seen along the river, in three parts: 1. Red gravelly clay, or "pebbly clay." 2. Laminated gray clay. 3. Red stony clay, the last being at the bottom.

There is but little change in the features of the country, from Squagemaw bridge to the mouth of the Savannah river. It is all arable and habitable land, and is destined to be filled with an agricultural population. There are vast tracts on the St. Louis, above the mouth of Big Whiteface that are burnt, but seem to have been generally more sandy than clayey, and are flat, the level being about 30 feet above the river. At some points above there is a heavy red-clay drift, and the banks are about 40 feet above the river. At the Big Whiteface the banks are about 20 feet above the river, and the adjacent country is flat. The Savannah river drains a flat country, underlain by clay (which at its mouth is red and horizontally stratified), and each tributary is skirted by a grassy border on each side, which, further up, becomes a tamerack swamp, but nearer the main river is enclosed by aspen, on flat ground but little above the river. The region of the Savannah river is generally timbered, mainly with aspen, somewhat with white oak and white pine and spruce, and an occasional tree of balm of Gilead. The old portage trail from the St. Louis to the Mississippi river, by way of the Savannah river, is now abandoned and obliterated. It is superseded by another 7 miles long, which leaves the St. Louis about on Sec. 27, T. 51, 20, about ¾ mile below the large island represented on the surveyor's township plats. This leads to Prairie Lake, and thence through Prairie river (when not too low), reaches Sandy Lake and the Mississippi. The country through which the portage passes is generally dry, but it passes through one cranberry swamp at about six miles from the St. Louis. The portage trail also lies on a glacial kame for some distance, at about 3¾ miles from St. Louis river. The country is not generally flat, but often undulating or even hilly, especially between three and four miles from the St. Louis. The kame mentioned runs some south of west, and has swampy tracts on the north and south sides. At 5 miles the drift was seen to be red clay, with pebbles.

The trees to be seen on this portage consist of the following, about in the order named for frequency: Aspen, white pine, white birch, balsam, tamarack, white spruce, Norway pine, soft maple, sugar maple, white cedar, ironwood, elm, ash (white and black), blue beech, black and bur oak, small red cherry (sometimes six or eight inches in diameter), bass, gray birch (small trees). There is much doubt whether the true black spruce grows in this

State, or in the northwest—such as seen in Maine and used there for lumber. Ours seems to be all white spruce, and rarely becomes large enough for boards, although it does sometimes. Mr. Lapham names hemlock as one of the trees of Minnesota, but it has never been seen by this survey, nor can any one be found who can name a locality where it grows in the State.

The level of Prairie Lake is about 135 feet above that of the St. Louis River where the portage leaves it, according to a series of Aneroid observations in an unfavorable state of the weather.

Prairie River being too low for canoes, a portage of 16 miles is still necessary to the shore of Sandy Lake. This portage discloses no rock, but passes through a good drift-covered, agricultural country, flat to undulating, all timbered, formerly with much good pine. The western part of the portage, however, passes through considerable tamarack swamp. The swamp occurs before crossing the W. Savannah River. On the west side of that river (which is a tributary of the Prairie River) the land is dry and sandy, with small Norway pines. The shores of Sandy Lake are of sand, with only occasional points of gravel, or small boulders.. On reaching the Mississippi River, the drift is seen to be *gray hardpan*, thus contrasting with the drift seen on the St. Louis, and on the portage trail to Prairie Lake. At four miles above Aitkin it is also gray and of the later drift epoch. The flood plain is 14 ft. above the river generally, but occasionally new flood plains, now making, are from 5 feet (or from zero) to 14 feet high. The new plains generally rise to the level of the old plain at their up-stream ends, where the two unite in one. the former gradually taking the place of the latter with an imperceptible diminution of height. This new plain sometimes extends, on one or both sides, for half a mile, or a mile, making it appear as if the real flood plain were but six or eight feet above the river. Suddenly a higher plain strikes in from the country in traveling down the river, and by a single step the level is as before about 14 feet. Of course the river has all stages between the level of very low water and some feet above this 14 feet flood plain, since there are water marks on the trees considerably higher than 14 feet. At a point a short distance below Sandy Lake is a sandy and timbered bluff about 25 feet high, having Norway pines. but with that exception there is no land between Sandy Lake and Aitkin visible along the river higher than this 14 ft. flood plain. The material of the flood plain is generally a horizontally stratified fine clay, varying to a fine sand, but the laminations are sometimes oblique near the water

level, and on the top sometimes the material is rather sand than clay. This flood plain is heavily timbered with elm, white oak, soft maple. These three make up more than ¾ of all the trees; but there are also white birch, aspen, bass, black ash, white ash, gray birch, sugar maple, willow and among the conifers a sprinkling of white pine, balsam, spruce, tamarack (and one tree of white cedar.)

Between the river and the village of Aitken, a distance of one mile, the country generally is not much higher than the above-mentioned flood-plain, and rises imperceptibly from the river to the railroad, about five feet, the alluvium being replaced superficially by a gray hardpan, with boulders on the surface, the timber being also much the same.

At about 15 miles below Aitkin appear unmistakable traces of a permanent higher flat, where it approaches the river and has been cut off like a terrace-step by the action of the current. It is two to four feet higher than the flood-plain, but even then still appears to taper down stream to the level of the real flood-plain. In descending further this higher flat becomes more and more marked and persistent, the river itself also having apparently a lower flood-plain than before, so that the real difference in hight between the two plains is about 14 feet. This upper flat where it approaches the river, is markedly different from the lower flat which accompanies the river nearly all the way. It has small timber, and a few scattering pines, with occasionally a clump of balsam or spruce, or is a devastated burnt plain, while the lower flat is timbered heavily with large trees of elm, oak, ash, and basswood, and is rarely invaded by fire. The upper flat is also very different from the lower in composition. For the most part it is a stony or pebbly drift clay, from the river upward (in one case seen to be a "pebbly clay" for 20 feet) with a rusty or yellowish sand on the top, though in some spots the sand is almost wanting—but the lower flat is a fine alluvium, generally a laminated clay.

Further down the river, as at the mouth of Pine river, this upper flat is unusually elevated, being about 80 feet above the flood-plain; while at points above it is seen to gradually increase in hight in descending the river, the most common elevation being 40 or 50 feet above the flood-plain. The same change is to be seen at and above Pine river as already noted. A lower flood-plain is seen to rise within the real flood-plain, at its upper end being nearly of the hight of the 14 ft. flat, and at its lower to gradually become less and less till it sinks to the level of the water. The

highest flat has Bank's pine at Pine river, and at some distance above. The high banks, where favorably exposed by slides, are seen to be composed of gray clay, generally pebbly, but usually with boulders in the river adjacent. This clay is covered with a varying thickness of yellow stratified sand. The clay has some limestone, as from Winnipeg.

But below the mouth of Pine river, about one mile and a half, a red clay is exposed in a number of places, in cuts in the high banks of the river. This is stony and sandy, and is the probable source of the rusty sand seen to be lying over the gray clay already mentioned. Still further down, this red clay is seen overlain by much rusty sand. As a rolling or undulating surface gradually comes on, the cuts are generally of this sand, or stones and sand with little clay, the river running faster and having a flood-plain of only six or eight feet hight. The gray color is still seen in low plains or flats lying between the red knolls, but, generally speaking, a change from gray drift clay to red takes place at the mouth of Pine river.

At the French Rapids, a short dirtance above Brainard, is a high and rolling tract of red drift which furnishes the boulders of the rapids. These hills rise 100 feet above the river just above the rapids.

Below Brainerd the country is very sandy and undulating, and the flood-plain seems to be almost wanting. The timber is mostly of Bank's pine. About Crow Wing there is less sand, but abundance of little stones and of gravel, and the banks are only 8-10 feet high, with rapid current and almost no floodp-lain. Higher drift banks are visible in the distance, east and west. Below the French Rapids the real "red clay" is not seen for some distance, at least to Fort Ripley, but in its place can be seen yellow sand and red sand, and almost clean sand, and below this a stony gray clay, or only stony slopes to the water. But as red clay the drift appears only where mentioned, at and below the mouth of Pine river to the French Rapids.

Olmstead's Bar is a long shoal, about two miles below Fort Ripley, and the flood plain is low. No bedrock is visible—only stones from the drift. Prairie Rapids are near Belle Prairie, and are similar to Olmstead's Bar. At Belle Prairie the flat sets in on which is Little Falls, though it really begins some miles above, although further north it is undulating, and can hardly be styled a continuous flat to Brainerd. It still seems to have been once the flood-plain of the river, in the same manner as at Little Falls. It is

probable that then, as now, the river had a swifter current above Belle Prairie, and left on this plain a sandy sediment, and a surface more susceptible to change by wind, and less adapted to vegetation, circumstances which have tended to bring about a moderately broken surface. It is probable that an ancient morainic belt is crossed by the Mississippi between Pine river and French rapids.

III.

PALÆONTOLOGY.

New Brachipoda from the Trenton and Hudson River formations in Minnesota,

By N. H. WINCHELL.

ORTHIS WHITFIELDI (N. sp.)

Shell semi-oval, the hinge-line being a little less than, or equal to the greatest transverse diameter, the cardinal angles being a little greater than 90 degrees, the edge passing in a regular semi-oval curve through the antero-lateral angles, but sometimes with a very slight inclination in front toward the side of the receiving valve. Size varying from 9½ to 14 lines in transverse diameter, and from 8 to 11½ lines in perpendicular diameter, in the large size the convexity being, between the umboes, 6½ lines.

The receiving valve has a distinct and full beak and umbo, from which the surface slopes evenly to the margin all round, but having a little flatness at the cardinal angles. The cardinal area is arched, and at its union with the cardinal area of the entering valve forms an angle with it of nearly 90 degrees; its hight is about 1-6 its length: its foramen is triangular and reaches the beak, the width across the base being somewhat less than the hight; plications of the surface are strong, direct and simple, but double their number on the umbo by implantation, and again in the same way* before reaching the margin, where they number from 36 to 48. Between the *plicae* are fine cross-ridges which sometimes rise to the tops of the *plicae*, but do not cross them so as to be preserved

*By implantation is meant that method of increase which is seen in the rise of intermediate folds in the surface of the shell between the older *plicae*, whether the new fold be in the middle, between the others, or is seen first to be nearer one than the other of the older folds, there being no change in the size nor direction of the larger folds. Bifurcation signifies a nearly equal division of the larger folds which at first lessens their size and changes their direction.

in our specimens. A cast of the interior of this valve shows a distinct general muscular impression, reaching a little more than one-third the perpendicular diameter of the valve from the beak, and divided longitudinally into shallow furrows and ridges converging within the beak, four of the former and five of the latter, with a cross-striation visible on that portion between the teeth and near the foramen. The central ridge in the general muscular impression on the cast, does not reach the front margin of the scar, but gradually dies out, giving place to the adjoining parallel furrows which widen and coalesce, and show a longitudinal finer furrowing or striation. The next ridges, on either side, are marked and prominent, extending to the anterior angles of the scar, giving it a nearly straight, elevated front and angular corners, somewhat as in *O. subquadrata.* The two outermost ridges are fainter, but extend to the lateral margins of the scar. Still outside of all these ridges are traces of a similar furrowing within the beak, embracing that portion between the teeth which has the fine cross-striation. The outward plications of the valve are strongly marked on the cast for about $2\frac{1}{2}$ lines from the margin, and some of them run faintly even to the edge of the muscular scar.

The entering valve is much less convex, but cannot be said to be flat, though it has a faint flattening along the center, which widens to the front margin where it is changed, in the large specimen, to a slight concavity and produces a straightening, and also a very slight flexure, of the margin. In front of the cardinal angles also, on either side, is a flat or depressed area; cardinal angle parallel with the posterior margins of the valve, and a little more than one half the hight of that of the receiving valve; beak indistinct; foramen triangular and about as wide as high, with a small central, smooth tooth which does not rise above the plain of the area, and only becomes visible on being cleaned and excavated. A cast of the interior of this valve shows marked internal characters. While the impressions of the individual diviricator and adductor muscles on the same side are not separable with certainty, owing to the faintness of the lines between them, the pairs of each are divided, on the cast, by a deep, sharp furrow that extends from the beak where it divides the divaricately striated cardinal process into two equal lobes, toward the front between the depressions of the hinge-teeth, to a point somewhat more than $\frac{1}{3}$ the diameter from the beak, when it dies away, or runs into a broad, abrupt, medial depression which produces the flatness in the valve extending to the front margin. The external *costae* are deeply impressed on the

cast about the margin, some of the lines running faintly within the vascular area. The exterior of this valve is also marked by concentric fine striations, especially between the *costae*.

This species resembles Meek's description of *O. fissicosta*, H. more than any other, but in that the valves are nearly equally convex, the receiving valve has an abruptly pointed beak and a narrow foramen, and the external *costae* are 19 or 20; the interior of the dorsal valve has no "defined muscular scars so far as known" (Meek), the muscular scar of the receiving valve has an oval-sub-trigonal outline, with two linear ridges that do not continue round the front; and the size of the shell is much less than this, our smallest specimen being two lines wider than the largest ever mentioned of that species.

Named in honor of R. P. Whitfield of New York.

Formation and Locality. In the Galena beds of the Hudson river formation, at Spring Valley in Fillmore county.

Museum Register Numbers 277 and 429.

Collector, N. H. Winchell.

ORTHIS SWEENEYI (N. sp.)

Shell suborbicular, with a straightening along the hinge-line, and having the general aspect of *Orthis pectinella*, but with a shorter hinge-line.

The receiving valve is convex, with flattened lateral marginal areas and cardinal angles; *costae* coarse and simple, numbering about 22, all of which continue to the beak except two or three on each side, which in passing from the margins in front of the cardinal angles, rather terminate on the hinge-area. The *costae* and the furrows, which have about the same width, are crossed by fine, crowded, concentric *striae;* beak distinct, but not much elevated above the margin of the area; area slightly arched, but directed in the plane of the edges of the valves; area triangular, equilateral, containing a simple tooth which rises to the apex but is not developed so as to appear in the plane of the cardinal area, but is horizontally ribbed on either side. Interior unknown.

The entering valve is flat, with a little elevation at the beak and umbo, and a broad slight concavity between the umbonal region and the front margin; *costae* the same as on the convex valve; beak small and more abrubt than that of the other valve; area low and flat, but of nearly the same hight as that of the other valve,

with which it forms an angle of about 45 degrees; foramen partially closed, but open below, broadly triangular.

The transverse diameter is seven lines in the single specimen belonging to the survey, and the perpendicular is six.

This species in general aspect greatly resembles *O. pictinella* of Conrad, but is essentially different, in that the foramen and area are on the flat valve instead of the convex one, the perpendicular diameter compares to the transverse as 9 to 12 instead of 6 to 7, the cardinal line is extended so as to equal, or nearly equal, the transverse diameter, and no mention has been made of the existence in that of a cardinal tooth in the foramen of the convex valve.

Named from Dr. R. O. Sweeney, of St. Paul.

Formation and Locality, in the lower part of the Hudson river Shades, at St. Paul.

Collector, N. H. Winchell.

Museum Register Number, 3,520.

GENUS STROPHOMENA (*Rafinesque, 1825.*)

(Manuel de Malacologie, of Blainville.)

Under *Orthisidal* Mr. McCoy has included (1855, *Bret. Pal. Foss.*) 1. *Porambonites*, 2, *Orthis*, 3 *Orthisina*, 4 *Leptæna*, 5 *Strophomena*, 6 *Leptagonia*, and 7 *Chonetes*, but under *Leptæna* he places *Leptæna*, "*restricted*," *Strophomena*, Rof. *Leptagonia*, McCoy, and *Chonetes*, Fisch, as subgenera, with the following distinctions, viz.:

1, *Leptæna* of Dalman, restricted to the type of his last species (*L. transversalis*), in which the valves are almost equally curved in the same direction, the receiving, or foraminated one, convex, the other concave outwardly.

2. *Strophomena*, in which the valves are flat, or very slightly convex when young, the margin in a few species becoming, by age, deflected, usually toward the receiving valve, as in *S. rugosa* (Rof.) —resupinate species.

3. *Leptagonia* (McCoy), with both valves abruptly bent at right angles toward the entering valve, and the rosteal portion concentrically wrinkled.

4. *Chonetes* (Fisher), only different from Leptæna (as restricted) by having a row of spines on the hinge-line, thus approaching *Productus*.

By this classification most of his species fall under *Leptæna*.

Mr. Billings, in 1860,* makes two groups of the Genus *Stophomena*, taking *S. alternata*, of Conrad, as the type of one, and *S. filitexta*, of Hall, as the type of the other. Of these the former has the entering (dorsal) valve concave, or sometimes nearly flat, and includes the species *alternata* (Con.), *deltoidea* (Con.), *camerata* (Con.), *tenuistriata* (Sow.), *incrassata* (Hall), *nitens* (Bill.), *Ceres* (Bill.), *Leda* (Bill.), *Philomela* (Bill.), *imbrex* (Pan.), and *rhomboidalis* (Wilck), and perhaps others. The latter group contains the resupinate forms which have a concave receiving valve, viz: *filitexta*, (Hall), *fluctuosa* (Bill.), *recta* (Con.), *planoconvexa* (Hall), *antiquata* (Sow.), *planumbona* (Hall), and *subtenta* (Con.)

At the same time Mr. Billings retains under *Leptæna*, the species *decipiens* (Bill.), and *sordida* (Bill.), as well as *sericea* (Sow.), without specifying what difference he relies on to distinguish *Leptæua* from *Stophomena*.

Mr. Meek has maintained the genus *Leptæna* by describing and figuring *L. sericea* (Sow.) in the First Volume of the Palaeontology of Ohio, and divides the genus *Strophomena* into two parts, one of which represented by *S. rhomboidalis*, Wilckens, is taken as the type of the genus, and is the equivalent of the *alternata* group of Billings, and includes both the restricted *Leptæna* and the *Leptagonia* groups of McCoy. The resupinate species he distinguishes by placing them together under the sub-genus *Hemipronites*.

The conflict which exists between these two generic names (*Strophomena* and *Leptæna*) seems to have arisen from two causes. 1st, their nearly synchronous adoption and use in different countries, and 2nd, the very general and incomplete definitions by which they were made known. Dalman's genus, *Leptæna*, was erected in 1827 (Kongl. Vet. Acad. Handl.) and embraced not only the type form *rhomboidalis* (under other specific names), and species of *Productus*, but also other types of *Strophomena* and *Leptæna*, as those genera are now usually understood (Meek), while Rafinesque's genus, *Strophomena*, though used by him and Defrance, in brief and unsatisfactory allusions, for several years before, was fairly published as early as 1825, when Blainville figured and published a brief description (*Man. de Malacol.*) But in this description Mr. Meek says that doubtless an American resupinate specimen, later named *planumbona* by Hall, was described under one of Rafinesque's names (*rugosa*, adopted from Dalman, applied by him to a non-resumpinate form). Hence it is evident, not only that each

**Canadian Naturalist and Geologist*, Vol. 5, 1860; and *Pal. Foss.*, Vol. 1, p. 115.

author included all the forms under his own designation, but that they had not noted the distinctions that were subsequently brought out. The names must therefore be regarded as perfectly synonymous, and the earlier published, under the recognized law of priority, should take precedence.

The remarkable differences that divide these brachiopods into resupinate and non-resupinate groups, seem to call for a generic designation for the resupinate species. Provisionally therefore we shall follow the suggestion of Mr. Meek and range these species under Pander's genus *Hemipronites*, proposed in 1838 but not defined. For the present the Permian and Carboniferous name of *Streptorhynchus*, proposed by Prof. King in 1850*, though perhaps covering some of our species according to the discrimination of Prof. James Hall in the 4th volume of the Palaeontology of New York, (p. 64) may be restricted perhaps to the rocks of that later geological horizon, when its characters are fully exemplified.

Gen. Char. Shell semi-circular, or semi-oval, with a hinge-line about equal to the transverse diameter, a convex receiving valve when adult, and a flat or concave entering valve, narrow cardinal area, inconspicuous or small and abrupt beaks, and radiately and concentrically striated exterior; receiving valve with a minute perforation in the beak, its foramen nearly or quite closed by the divided cardinal process of the other valve which is more or less covered by a deltidium rising from one or both valves†; visceral disc of the receiving valve frequently rugose concentrically.

STROPHOMENA MINNESOTENSIS (N. sp.)

Synonymy and Reference.—Leptaena deltoidea, *Owen*, Geol. Rep. Wisc. Iowa and Minn. p. 629, Tab. II, b. fig. 10. Winchell, Geol. & Nat. Hist. Survey, Minn. Rep. for 1872, p. 101. *Ibid* for 1876 p. 148 and 212, *Ibid* for 1879 p. 62.

Shell semi-oblong or semi-oval, with the cardinal angle about 90 degrees, or less than 90 degrees; diameter from six to nine lines transversely, and from four and a half to eight lines perpendicularly; the receiving valve convex, sometimes more suddenly deflected after passing the visceral area; entering valve gently concave, but flexed more rapidly about the margin; the exterior of the convex valve marked by fine radiating striæ, every third, fourth or fifth one being larger than the intervening ones; interior of the convex

*Monograph of Permian Fossils, 1850, p. 107.

†Prof. James Hall says (16th Reg. Rep, p. 63) that *S. rugosa* (*rhomboidalis*) and *S. alternata* have a deltidium on the dorsal (concave) valve. S. aspera, Jams, has also.

valve, which is best known from its frequent casts, shows a large muscular impression much resembling that of *S. alternata* as figured by Meek in Vol. I. Pal. Ohio, plate VII. fig. 3c. but somewhat bilobate in front, and larger in proportion to the size of the valve; scars of the abductor muscles closely approximate, small and in many casts of this valve undistinguishable; behind they are separated (on the casts) by a short merial ridge, which between them becomes at first a narrow mesial furrow and then a deep furrow, terminating at the sinus between the outer, larger, scars; the outer larger scars (cardinal muscles) are radiately striated from the beak; their margins are strongly marked (on the cast) along their posterior sides by distinct grooves formed by the dental plates, which diverge at once from the foramen at an angle of 100-120 degrees, running nearly straight to the outer margins of the muscular scar, when they curve slightly toward the front; the anterior and lateral margins of the general muscular impression are slightly marked on the casts; outside of the muscular scar is a shallow marginal impressed line which is most evident at the cardinal angles as it converges toward the beak; interior edge of the cardinal line is carinate, from the teeth to the cardinal angles; the details of the markings in the apex of the beak are seen on the valve itself to consist of two short, distinct, diverging ridges extending not much beyond the hinge-teeth, between the anterior ends of which rises a short mesial ridge of about the same size and length, with faint linuar ridges parallel with it on each side, which extend a little further forward than the mesial ridge. The mesial ridge first gives place to a flat unmarked interval, when it again rises more conspicuously, but narrower and sharper, extending nearly to the sinus separating the lobes of the outer muscular scar. The cardinal area of the convex valve slopes from the hinge-line obliquely backward, instead of being in plane with the lateral edges, thûs differing from *S. alternata*. From three to five short undulations of the shell transverse to the cardinal line, are seen often between the umbo and the cardinal angles the heavier ones being near the cardinal angles. The cardinal process is bifid and prominent, but not spreading or fan-shaped, the two parts being short, smooth, dantate protuberances that stand prominently exposed about parallel with the plane of the cardinal area.

The interior of the entering valve is very different from that of the entering valve of *S. alternata*. The general visceral disc is nearly flat, surrounded by a suddenly flexed margin, inside of which is a shallow impressed broad line, most evident round the front:

inside the cardinal angle are a few scattered, radiately-interrupted, short ridges or elevations, but these do not prevail along the side nor in front, the surface there being smooth or finely granulated instead; in the center of the valve are five smooth, abrupt, digitately spreading ridges, the middle one of which is a little larger and longer than the others; these rise more abruptly at their anterior extremities than behind, but none of them reach the beak, or even the umbonal region, though the exterior pair of lateral ones are placed further back than the others, converging at an angle of about 70°. Socket ridges very short and widely divergent; behind them are small, doubly groved sockets.

Formation and Locality: This species occurs in the sub-crystalline dolomytic layers of the upper part of the Trenton, at Minneapolis. It exists most numerously as casts, of which hundreds are obtainable. Sometimes they nearly cover slabs when split open in quarrying, associated with *Hemipronites filitextus* (Hall), *Orthis tricenaria*, and species of *Murchesonia* and *Edmondia*. They do not vary much in size. They have been referred to in describing the rock at the falls of St. Anthony, by Dr. D. D. Owen, as *S. deltoidea*, and, following his identification, by the writer in reports of progress of the survey. Without seeing the interior of the flat valve, it is nearly impossible to distinguish this species from *S. alternata* of Conrad, except that it is much smaller than that species generally is.

Collectors. N. H. and H. V. Winchell and C. L. Herrick.

Museum Register Numbers. 3521 (=180), 681, =3522 (199), 2192 and 3523.

IV.

THE MUSEUM.

REPORT FOR 1880.

The south room of the Museum has been rendered more attractive and useful by the erection of a large, single, central case in the middle of the room, designed to contain distinctively the rocks, fossils, minerals and soils of Minnesota. Into this have been placed such portions of the survey collections as are ready to be put on exhibition, or that could be spared from the laboratories. In the lower portions of the other cases in the same room have been placed additional shelving, which nearly doubles the former capacity of those cases. Here have been arranged rock-samples from various parts of the United States, and from Europe, as well as large specimens of ores and minerals that could not be contained in the tops of the same cases. One of these has been set aside for archæological specimens.

The zoological collections in the north room have been increased by the contribution of two series of specimens by the Smithsonian Institution, constituting Set 37 of *Invertebrata*, containing 155 species, and Set 46 of *Fishes*, containing 73 species, on behalf of

the United States National Museum, from collections of the United States Fish Commission, through the courtesy of Prof. S. F. Baird.

Specimens presented to the Museum will be found enumerated and acknowledged in the following catalogue:

SPECIMENS REGISTERED IN THE GENERAL MUSEUM IN 1880.

[GEOLOGICAL AND MINERALOGICAL.]

Serial Numbe.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
3364	May, 1879	Geol. Survey......	Shakopee Limestone (fossiliferous)................	Ind	Sec. 5, Stanton Good. Co	Low Mag..	N. H. Winchell................
3365	"	"	St. Lawrence Limestone........................	"	Frontenac, Goodhue Co	" ..	" ....
3366	"	"	St. Lawrence Limestone	4	Red Wing, Goodhue Co	" ..	" Berglund's quarry
3367	"	"	Fossiliferous chert............................	2	" "	St. Lawr..	" "
3368	"	"	Dendrites	1	" "	" ..	" "
3369	"	"	Drusy geodes and nodules.......................	....	Mazeppa, Wab. Co......	....	" ....
3370	"	"	Green Sandrock	4	Central Point...........	St. Croix..	" ....
3371	"	"	Greenish dolomitic Sandrock 1x1 ft..............	Ind	"	" ..	" ....
3372	"	"	White Sandrock.................................	....	"	" ..	" ....
3373	"	"	Tufa (calcareous)...............................	6	"	....	" ....
3374	"	"	Shale (containing trilobite remains)..............	Ind	Barn Bluff, Red Wing..	St. Croix..	" ....
3375	"	"	Green Sandrock	....	Hay Creek, Goodhue Co	" ..	" ....
3376	"	"	Stalactitic calcareous coatings..................	3	Barn Bluff, Red Wing ..	St. Lawr..	" ....
3377	"	"	Organic forms (orthocrata ?).....................	2	" "	" ..	" ....
3378	"	"	Receptaculites. Sp. ?............................	1	Sec. 12 Holden Good. Co	Hud. R....	" ....
3379	"	"	Fossiliferous slabs	2	Kenyon, Good. Co......	"	" ....
3380	"	"	Trenton Limestone..............................	4	Stanton, Good. Co......	Low Trent.	" ....
3381	"	"	(Upper) Trenton Limestone.......................	Ind	Kenyon, Good. Co......	Up. Trent.	" ....
3382	"	"	Red Wing stone-ware clay........................	2	Goodhue Co.............	....	" ....
3383	"	"	"Slip Clay" (Albany, N. Y.)	1	Albany, N. Y...........	....	" (used at Red Wing)
3384	"	"	Stone Ware.....................................	....	Red Wing...............	....	" ....
3385	"	"	Conglomerate (ferruginous)	3	Cherry Grove, Good. Co	Dakota (?)	" ....
3386	"	"	St. Peter Sandstone.............................	Ind	White Rock, Good. Co.	St. Peter ..	" ....
3387	"	"	Combustible Shale..............................	1	Zumbrota, Good. Co....	Trenton ..	" ....
3388	"	"	Combustible Shale..............................	7	Sec. 25 Stanton Good. Co	" ..	" ....
3389	"	"	Lingula Coburgensis, Bill........................	1	Kenyon, Good. Co......	Up. Trent.	" ....
3390	"	"	(Upper) Trenton Limestone.......................	3	Cherry Grove, Good. Co	"	" ....
3392	"	"	Trenton Limestone	4	Cannon Falls, Good. Co	Low Trent.	" ....
3393	"	"	Upper Trenton Limestone..........................	2	Sec. 8. Wanamingo, Good. Co...........	Up. Trent.	" ....

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens	Locality.	Formation.	Collector and Remarks.
3401	May, 1879	Geol. Survey	Trenton Limestone	1	Zumbrota, Good. Co.	Low Trent.	N. H. Winchell
3402	"	"	Fossiliferous slabs	Ind	Sec. 25 Stanton Good. Co	Hud R.	"
3403	"	"	Shakopee Limestone	3	" " "	Shak	"
3404	"	"	St. Lawrence Limestone	3	Mazeppa, Wab. Co.	St. Law.	"
3406	"	"	Magnesian Limestone	2	Cherry Grove, Good. Co	Galena.	" ..... [blue clay
3407	"	"	Wood	3	Sec. 25 Roscoe, Good. Co	Drift	N. H. W. 33 feet under loam in
3411	"	"	"Frontenac Stone"	Ind	Sec. 19 Chester, Wab. Co	St. Law.	N. H. Winchell
3412	"	"	"Frontenac Stone"	1	Sec. 4, Mt. Pleasant, Wab. Co.	"	"
3413	"	"	Sandstone with Graptolites	....	Wabasha, Wab. Co.	St. Croix	"
3414	"	"	Boulder of felsite with red orthoclase crystals	1	Zumbrota, Good. Co.	Drift	"
3415	"	"	From the big boulder of granite	2	Sec. 29 Belle Cr. Good. Co.	"	"
3416	Apr. 1880	R. J. Baldwin	Hallite	2	Nevada, Col. Valley		Presented by R. J. Baldwin
3418	1879	Geol Survey	Brick	1	Le Sueur, Le Sueur Co.		W. Upham H. Kruse's yard
3419	"	"	"	1	Jordan, Scott Co.		" C. Rodell's yard
3420	"	"	"	1	Shakopee, Scott Co.		" Shroeder Bro's yard.
3421	"	"	"	1	Otsego, Wright Co. ½ mi. w. of Dayton		" Medorre Arseno yd.
3422	"	"	"	2	Kokato, Wright Co.		" James Runion's yd.
3423	"	"	"	1	Litchfield, Meeker Co.		" Henry Ames' yard
3424	"	"	"	2	New London, Kandiyohi Co.		" Peter Larsen Jr., yd.
3425	"	"	"	2	Glenwood, Pope Co.		" John Alton's yard.
3426	"	"	"	1	Redwood Falls, Redwood Co.		W. Upham, Bohn & Lamberton's yard
3427	"	"	"	1	Sec. 2, Lake Mary, Douglas Co.		" Mark Bundy's yard.
3428	"	"	"	1	Alexandria, Douglas Co.		" J. A. McKay's yard.
3429	"	"	"	1	Evansville, "		" Partridge Bro's yd.
3430	"	"	"	1	Parker's Prairie, Otter Tail Co.		" Henry Asselus' yard.

3431	1879	Geol. Survey	"	1	Fergus Falls, Otter Tail Co.		" Nelson Bro's yard
3432	"	"	"	1	Detroit, Becker Co.		" Martin & Shaw's yd.
3433	"	"	"	1	Moorhead, Clay Co.		" Lamo Bro's yard
3434	"	"	Brick clay		New London, Kan. Co.		" Peter Larson's yard.
3435	"	"	" "		Fergus Falls, Otter Tail Co.		" Nelson Bro's yard
3436	"	"	" "		Detroit, Becker Co.		" Shaw & Martin's yd.
3437	"	"	Granite (red)	2	2 mi. S. of Ortonville		" From a R. R. cut
3438	"	"	Granite (red)	2	3½ mi. S. of Ortonville		" " " .[Co
3439	"	"	Granite (red)	3	S. E. ¼, Sec. 32, T. 121, 45		W U Yel'w-banks, Lacqui Parle
3440	"	"	Granite (coarse red)	3	S. E. ¼, Sec. 31, T. 121, 44		W U R.R. cut 3 mi. w. of Correll
3441	"	"	Gneiss (red quartzose)	3	1½ mi. S. E. of Montevideo		W. Upham R. R. cut
3442	"	"	Gneiss (red quartzose)	1	1½ mi. S. E. of Montevideo		" near R.R. in highw'y
3443	"	"	Gneiss (red)	2	Granite Falls		" n'r WWPinney's mill
3444	"	"	Hornblende schist	1	"		" E. end of "
3445	"	"	Gneiss (quartzose)	2	Minnesota Falls		" N. end of bridge
3446	"	"	Gneiss (flesh red)	1	Swede's Forest, Redwood Co.		
3447	"	"	Gneiss	3	Opp. Redwood Falls, Sec. 20, Beaver Falls		" ¼ m N. of ford
3448	"	"	Kaolin (from a feldspar vein in gneiss)	1	S. W. ¼, Sec. 21 Beaver Falls		W. Upham foot of hill descending to Red. Falls ferry
3449	"	"	Kaolin (from kaolinized gneiss)	1	S. W. ¼, Sec. 21, Beaver Falls		W. Upham, foot of hill descending to Red. Falls ferry
3450	"	"	Gneiss	3	Beaver Falls village		W. Upham dam of Champ. mill
3451	"	"	Gneiss	3	" Renville Co		"
3452	"	"	Porphyritic Gneiss	3	1½ mi. w. of Ft Ridgely		"
3453	"	"	St. Lawrence Limestone	1	Jordan, Scott Co.		"
3454	"	"	Jordan Sandrock		Jordan, Scott Co.		"
3455	"	"	Shakopee Limerock		Shakopee, Scott Co.		"
3456	"	"	" "		Ottawa, Le Sueur Co.		"
3457	"	"	" "		Hamilton, Scott Co.		"
3458	"	"	White Clay (from vertical seam in Shakopee)		Ottawa, Le Sueur Co.		"
3459	"	"	Red Clay (paint clay)		½ mi. S. of Ottawa Sta.		"
3460	"	"	Yellow upper part of till	1	N. E. ¼ Sec. 10, Sacred Heart, Renville Co.		"
3461	"	"	Bluish lower part of till	1	N. E. ¼ Sec. 10, Sacred Heart, Renville Co.		"
3462	"	"	Crag (same as 2507)	3	1½ mi. E. of St. Michael	Drift?	"
3463	"	"	Shell marl ("white earth")		S. E. ¼ Sec. 28. T. 141, 41	Drift.	"
3464	"	"	Calcareous Tufa	Ind	2 mi. w. of Glenwood	"	"
3465	"	"	" "	"	N. W. ¼, Sec. 22, Hawk Co.	"	"
3466	"	"	" "	"	¾ mi. S.E. of Montevideo	"	"

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
3467	1879	Geol. Survey......	Calcareous Tufa..........................	Ind	N. E. ¼, Sec 26, Fanoburg, Chip. Co.......	Drift	" ....
3468	"	"	" " (sparingly fossiliferous)	"	2½ mi. N. W. of Ortonville ....[Sec. 8	"	" ....
3469	"	"	Crag (fossiliferous) compare 3462, 3311 and 3385 ...	12	Hawk Creek, S. E. ¼,	Drift?	" ....
3470	"	"	Boulder of fossiliferous Sandrock	2	3 mi. N. W. of Monticello, Wright Co....	Drift	" ....
3471	"	"	" " Limestone	1	Sec. 34 Willmar, Kan. Co	"	" ....
3472	"	"	" " "	1	Dayton, Hennepin Co..	"	" ....
3473	"	"	Pyritiferous clay, iridescent shells and selenite...	....	2 mi. S. W. of Campbell, Wilk. Co.......	"	" ....
3474	"	"	Silicified wood	2	Near Campbell Wilk Co	"	" ....[Champion
3475	"	"	Fossiliferous pebble.............................	1	Near Campbell Wilk Co	"	" Presented by H.
3476	"	"	From a granite boulder, 20 ft. long...............	1	⅓ mile S. W. from Castle Rock.........	"	" ....
3477	"	"	From a heavy doleritic boulder	1	3 mi. N. W. of Montevideo...............	"	W. Upham, (resembles the Duluth rock. N. H. W.) ..
3478	"	"	From a boulder of granite 12 inches in diameter.	3	N. W. part of Sec. 13, Hoff. Pope Co.......	"	" .....[feet all angular
3479	"	"	From a boulder of hornblende schist.............	2	Oscar, Otter Tail Co....	"	" some fragments 3½
3180	"	"	Kidney Iron Pebble (oxidized in layers)	1	Green Lake P. O.........	"	" (from the Cretaceous)
3481	"	"	Glaciated Pebble	1	3 mi. N. W. of Ft Ridgely	"	" ....
3482	"	"	Glaciated Limestone Pebble	1	Muskoda..................	"	" ....
3494	"	"	*Strophemena aspera* (James).....................	3	Oxford Mills near Cannon Falls...........	Hud. R....	N. H. Winchell.................
3499	1877	"	*Lingula Elderi. whit*............................	1	Wanamingo, Good. Co..	Trenton ...	N. H. Winchell.................
3500	1879	"	*Lingula elongata* (Hall)...........................	1	Minneapolis	" ...	Presented by W. D. Hurlburt
3501	Sept. 1875	"	*Lingula Elderi. whit*............................	2	Olmsted Co.............	" ...	same as No 291
3502	Aug. 1875	"	*Lingula Elderi. whit*............................	1	Fountain, Fill. Co......	" ...	Taylor's quarry, N. H. W.......
3503	May 1879	"	*Lingula Elderi. whit*............................	1	Minneapolis	" ...	(same as 645)
3504	"	"	*Lingula Perryi* (Bill)..............................	1	Minneapolis	" ...	H. V. Winchell..........[shale)
3507	Aug. 1879	"	*Crania Trentonensis* (H)...........................	1	St. Paul.................	Hud. R....	N. H. Winchell from 2578 (green
3508	"	"	*Crania granulosa* (Winch).........................	1	Minneapolis	Trenton ...	C. L. Herrick, from 691.........

3509	Mar. 1879	Geol. Survey	*Orthis tricenaria* (Con.)	Ind	Minneapolis	Trenton	Horace V. Winchell
3510	Aug. 1877	"	*Orthis plicatella* (H.)	3	St. Paul	Hud. R.	N. H. Winchell
3511	Apr. 1879	"	*Orthis testudinaria* (Dal)	1	Oxford Mills, Good. Co.	"	"
3512	"	"	*Orthis testudinaria* (Dal.)	Ind	Kenyon, Good. Co.	"	"
3513	Aug. 1877	"	*Orthis perveta* (Con.) (?)	2	Minneapolis	"	C. L. Herrick (larger than type)
3514	"	"	*Orthis media* (Winch.)	12	Minneapolis	"	"
3515	Apr. 1879	"	*Orthis circularis* (Winch.)	2	Oxford Mills, Good. Co.	"	N. H. Winchell
3518	Oct. 1875	"	*Orthis subquadrata* (H.) (?)	15	Spring Valley	Galena	"
3519	July 1880	"	*Orthis Minneapolis* (Winch.)	2	Minneapolis	Hud. Riv.	C. L. Herrick
3520	Aug. 1877	"	*Orthis Sweeneyi* (Winch.)	2	St. Paul	Hud. Riv.	N. H. Winchell
3521	1872	"	*Strophomena Minnesotensis* (Winch.)	1	Minneapolis	Trenton	" (same as 180)
3522		"	*Strophomena Minnesotensis* (Winch.)	Ind	Minnehaha	"	" (same as No 199)
3523	Aug, 1880	"	*Strophomena Minnesotensis* (Winch.)	1	Minneapolis	"	C. L. Herrick (the entering [valve.)
3524	May, 1879	"	*Strophemena aspera* (James)	3	Sec. 12 Holden Good. Co	Hud. R.	N. H. Winchell
3525	Apr., 1879	"	*Strophemena aspera* (James)	13	Kenyon, Good. Co.	"	"
3526	Apr., 1880	H. P. Vancleve	Volcanic Rock (basic)	2	Sandwich Islands	Igneous	[Honolulu From quarry S. of Punchbowl at
3527	"	"	Volcanic Tufa	1	"	"	From quarry S. of " "
3528	"	"	Volcanic Rock (gray)	1	"	"	From rock W. of " "
3529	"	"	Basaltic Column	1	"	"	Pali, head of Nuuani V'y, Oahee
3530	"	"	Rock Samples	4	"	"	" " "
3531	"	"	Volcanic Tufa	5	"	"	15,000 feet above the ocean
3532	"	"	Volcanic Scoria	1	"	"	
3533	1873	Geol. Survey	Niobrara, calcareous shale	1	Near Sioux City, Iowa	Niobrara	[problematicus N. H. W. shows Inoceramus
3534	May, 1880	S. S. Strong	*Pecopteris villosa* (Brugt.)	2	Mazon Creek, Grundy Co. Ill.	Coal Meas.	
3535	"	"	*Pecopteris hirsula* (Lesgr.)	2	Mazon Creek, Grundy Co. Ill.	"	
3536	"	"	*Pecopteris unita* (Brugt.)	2	Mazon Creek, Grundy Co. Ill.	"	
3537	Nov. 1879	M. Pettengill	Petrified Wood	1	Wyoming Territory, near Yel'stone Park		Through Regent Chute
3538	1875	Asb. Stone Co.	Asbestine Stone	1	Minneapolis		Manufactured at Minneapolis
3539	1880		*Ostrea falcata*	14		Cretaceous	No records
3540	1880		*Ostrea larva*	1		"	"
3541	1876	Centennial Exp.	Coal	2	Orange Free State		N. H. Winchell
3542	1873		Barite	1	Massachusetts		Records doubtful
3543	1879	Geol. Survey	Building Stone 1 ft. square	1	Red Wing	St. Law.	N. H. W. (Berglund's quarry)
3544	1875	"	" "	1	Mantorville	Galena	" (Wilson's quarry)
3545	1879	"	" "	1	Frontenac	St. Law.	" (Frontenac Stone Co.)
3546	1875	"	" "	1	Austin		"
3547	1879	"	" "	1	Fond du Lac	Potsdam	"
3548	Apr. 1876	"	Barite and Galenite	2	Potosi Mines, Mo.		Hon. Wm. R. Marshall
3549	Apr. 1880	A. R. McNair	Stromatopora (sp. ?)	1	Saratoga, New York	Trenton	Capt. A. R. McNair
3550	1873	Geol. Survey	St. Cloud red granite	1	St. Cloud		N. H. Winchell
3551	May, 1880	"	Drillings from artesian well at 310 feet		Mankato		Warren Upham
3552	"	"	" " 330 feet		"		"
3553	"	"	" " 380 feet		"		"
3554	"	"	" " 390 feet		"		"

Specimens Registered in the General Museum in 1880—Continued.

Serial number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality	Formation	Collector and Remarks.
3555	May, 1880	Geol. Survey	Drillings from artesian well at 450 feet		Mankato		Warren Upham.
3556	"	"	" " 495 feet		"		"
3557	"	"	" " 560 feet		"		"
3558	"	"	" " 600 feet		"		"
3559	"	"	" " 640 feet		"		"
3560	"	"	" " 645 feet		"		"
3561	"	"	" " 660 feet		"		"
3562	"	"	" " 1060 feet		"		"
3563	"	"	" " 1100 feet		"		"
3564	"	"	" " 1110 feet		"		"
3565	"	"	" " 1130 feet		"		"
3566	"	"	" " 1150 feet		"		"
3567	"	"	" " 1270 feet		"		"
3568	"	"	" " 1280 feet		"		"
3569	"	"	" " 1320 feet		"		"
3570	"	"	" " 1327 feet		"		"
3571	"	"	" " 1332 feet		"		"
3572	"	"	" " 1342 feet		"		"
3573	"	"	" " 1450 feet		"		"
3574	"	"	" " 1720 feet		"		"
3575	"	"	" " 1827 feet		"		"
3576	"	"	" " 1860 feet		"		"
3577	"	"	" " 2000 feet		"		"
3578	"	"	" " 2150 feet		"		"
3579	"	"	" " 2204 feet		"		"
3580	"	Mus. of Technol'gy	Halite	1	Wieliezka, Galicia		Liquid cavities with gas bubbles
3581	May, 1879	Geol. Survey	Trap-rock showing corrugated cooled surface	1	Temperance River	Cuprifero's	N. H. Winchell (No. 170 of sur.)
3582	Sep., 1878	"	Basalt columns	3	Grand Marias	"	N. H. Winchell (No. 536 of sur.)
3583	May, 1880	"	Building stone, 1 foot square	1	Minneapolis	Trenton	N. H. Winchell
3584	Dec. 1879	"	Fool's gold. (Rusty mica and sand	Ind	Western Minnesota	Drift	Presented
3585	May, 1880	Prof. P. H. Mell, Jr	*Natica striata*	1	Claibourne, Ala.	Tertiary	P. H. Mell, Jr., (by exchange)
3586	"	"	*Natica magna-umbilicata*	1	"	"	"
3587	"	"	*Natica mamma*	1	"	"	"

3588	Apr., 1880	Prof. P. H. Mell, Jr	*Oliva constricta*	1	Claiborne, Ala.	Tertiary	P. H. Mell, Jr., (by exchange)
3589	"	"	*Oliva dubia*	1	"	"	"
3590	"	"	*Oliva gracilis*	1	"	"	"
3591	"	"	*Rostellaria cuvieri*	1	"	"	"
3592	"	"	*Rostellaria Lamarkii*	1	"	"	"
3593	"	"	*Voluta Parkinsonii*	1	"	"	"
3594	"	"	*Marginella semen*	1	"	"	"
3595	"	"	*Marginella crassitabea*	1	"	"	"
3596	"	"	*Egeria subtrigonia*	1	"	"	"
3597	"	"	*Egeria rotunda*	1	"	"	"
3598	"	"	*Egeria veneriformis*	1	"	"	"
3599	"	"	*Pyrula concellata*	1	"	"	"
3600	"	"	*Corbula Murchisonii*	1	"	"	"
3601	"	"	*Corbula Alabamiensis*	1	"	"	"
3602	"	"	*Venericardia parva*	1	"	"	"
3603	"	"	" *transversa*	1	"	"	"
3604	"	"	" *rotunda*	1	"	"	"
3605	"	"	" *planicosta* (Con.)	1	"	"	"
3606	"	"	*Pectunculus minor*	1	"	"	"
3607	"	"	" *delloidea*	1	"	"	"
3608	"	"	" *ellipsis*	1	"	"	"
3609	"	"	" *obliqua*	1	"	"	"
3610	"	"	" *broderipii*	1	"	"	"
3611	"	"	*Nassa cancellata*	1	"	"	"
3612	"	"	*Buccinum Sowerbii*	1	"	"	"
3613	"	"	*Turbinolia pharetra*	1	"	"	"
3614	"	"	" *discodea*	1	"	"	"
3615	"	"	" *Maclurii*	1	"	"	"
3616	"	"	" *Stokesii*	1	"	"	"
3617	"	"	*Dentalium alternatum*	1	"	"	"
3618	"	"	" *turitum*	1	"	"	"
3619	"	"	*Astarte minutissima*	1	"	"	"
3620	"	"	" *Nicklinsii*	1	"	"	"
3621	"	"	*Teredo simplex*	1	"	"	"
3622	"	"	*Turritella lineata*	1	"	"	"
3623	"	"	" *carinata*	1	"	"	"
3624	"	"	" *umbvicata* (Lam.)	1	"	"	"
3625	"	"	*Mitra fusoides*	1	"	"	"
3626	"	"	" *lineata*	1	"	"	"
3627	"	"	*Ostrea divaricatus*	1	"	"	"
3628	"	"	*Turbo natacoides*	1	"	"	"
3629	"	"	*Cerithium striatum*	1	"	"	"
3630	"	"	*Lucina impressa*	1	"	"	"
3631	"	"	" *lunata*	1	"	"	"
3632	"	"	" *papyracea*	1	"	"	"
3633	"	"	" *compressa*	1	"	"	"
3634	"	"	Bone of a fish (?)	1	"	"	"
3635	"	"	*Bulla St. Hillairia*	1	"	"	"

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	Obtained. When.	Obtained. Whence.	NAME.	No. of Specimens.	Locality.	Formation.	Collector and Remarks.
3636	May, 1880	Prof. P. H. Mell, Jr	*Fusus bicarinatus*	1	Claibourne, Ala.	Tertiary	P. H. Mell, Jr., (by exchange)
3637	"	"	Shark's tooth	1	"	"	"
3638	"	"	*Plicatula Mantelli*	1	"	"	"
3639	"	"	*Cytheria Hydii*	1	"	"	"
3640	"	"	" *subcrassa*	1	"	"	"
3641	"	"	" *cornis*	1	"	"	"
3642	"	"	*Orbitolites interstitia*	1	"	"	"
3643	"	"	*Limulites Douglassi*	1	"	"	"
3644	"	"	" *Bouci*	1	"	"	"
3645	"	"	*Crepidula cornu-arietis*	1	"	"	"
3646	"	"	*Crassatella protexta* (Con.)	1	"	"	"
3647	"	"	" *alta* (Con.)	1	"	"	"
3648	"	"	*Siliquaria Claibornensis*	1	"	"	"
3649	"	"	*Solarium granulatum*	1	"	"	"
3650	"	"	*Egeria inflata*	1	"	"	"
3651	"	"	*Voluta cooperi*	1	"	"	"
3652	"	"	*Mitra Humboldtii*	1	"	"	"
3653	"	"	*Oliva Greenougii*	1	"	"	"
3654	"	"	*Mitra Flemingii*	1	"	"	"
3655	"	"	*Egeria inflata*	1	"	"	"
3656	"	"	*Marginella ovata*	1	"	"	"
3657	"	"	*Nucula media*	1	"	"	"
3658	"	"	" *Sedgewickii*	1	"	"	"
3659	July, 1880	Geol. Survey	Fossil marble	3	Isle Lamatte, G'd Isle Co., Vt.		S. F. Heath
3660	"	"	Calico marble	4	Swanton, Franklin Co, Vt.		"
3661	"	"	French gray marble	5	Isle Lamatte, G'd Isle Co., Vt.		"
3662	"	"	Hard marble—used for tiles	3	Sutherland Falls, Rutland Co., Vt.		"
3663	"	"	Dove marble	3	Swanton, Franklin Co. Vt.		"

3664	July, 1880	Geol. Survey......	Green slate....................................	1	Fairfield, Rutland Co., Vt..................	....	S. F. Heath	....
3665	"	"	Brandon marble..................................	1	Wheaton Quarry, Brandon, Vt.........	....	"	....
3666	"	"	Sutherland Falls marble..-..........................	1	Sutherland Falls, Vt....	....	"	Average grade......
3667	"	"	Rutland statuary marble..........................	2	Rutland, Rutland Co., Vt	....	"	....
3668	"	"	Governeur marble..................................	1	Governeur, New York..	....	"	....
3669	"	"	Middleburry marble................................	1	Middlebury, Vt.........	....	"	....
3670	"	"	Red marble..	3	Swanton, Franklin Co, Vt..................	....	"	....
3671	"	"	Black marble......................................	4	Isle Lamatte, G'd Isle Co., Vt..............	....	"	....
3672	"	"	Sutherland Falls marble, grade No. 1............	1	Sutherland Falls, Rutland Co., Vt.........	....	"	....
3673	"	"	" " grade No. 2............	1	Sutherland Falls, Rutland Co., Vt.........	....	"	....
3674	"	"	" " grade No. 3............	1	Sutherland Falls, Rutland Co., Vt.........	....	"	....
3675	"	"	" " best grade No. 3............	1	Sutherland Falls, Rutland Co., Vt.........	....	"	....
3676	"	"	Rutland marble (averages)..........................	1	Rutland, Rutland Co., Vt	....	"	....
3667	"	"	Columbian marble..................................	2	Rutland, Rutland Co., Vt	....	"	....
3678	"	"	Sutherland Falls marble..........................	1	Sutherland Falls, Rutland Co., Vt.........	....	"	....
3679	"	"	Marble..	1	Pittsford, Rutland Co., Vt..................	....	"	....
3680	"	"	Columbian marble..................................	1	Rutland, Rutland Co., Vt..................	....	"	....
3681	"	"	Italian marble....................................	1	....	....	"	....
3682	"	"	Purple slate......................................	2	Hydeville, Rutland Co. Vt..................	....	"	....
3683	"	"	Purple slate	2	Fairfield, Rutland Co., Vt..................	....	"	(Vt. Union Co.)......
3684	"	"	Red slate..	2	Fairfield. Rutland Co., Vt..................	....	"	" ......
3685	"	"	Green slate..	1	Fairfield, Rutland Co., Vt..................	....	"	" ......
3686	"	"	Green slate..	2	Hydeville, Rutland Co. Vt..................	....	"	....
3687	"	"	Soapstone	2	Cambridgeport, Westminster, Windom Co., Vt.	....	"	(Smith quarry)......
3688	"	"	Marble..	1	Dorsant, Rutland Co, Vt.	....	"	....
3689	"	"	Laponto marble....................................	1	Hudson, N. Y...........	....	"	....
3690	"	"	Westerly marble..................................	1	Westerly, R. I..........	....	"	....
3691	"	"	....	1	Chester, Vt.............	....	"	....
3692	"	"	....	1	Fitz William, N. H......	....	"	....
3693	"	"	Granite..	2	Slayton, N. Y...........	....	"	....

Specimens Registered in the General Museum in 1880—Continued.

Serial Number.	OBTAINED. Where.	OBTAINED. When.	NAME.	No. of Specimens.	Locality.	Formation	Collector and Remarks.
3694	July, 1880	Geol. Survey		1	Fitz William, N. H.		S. F. Heath
3695	"	"	Granite	2	Quincy, N. H.		"
3696	"	"	Iron ore (magnetite)	2	Port Henry, N. Y.		"
3697	"	"			Sutherland Falls, Vt.		" from marble quarry
3698	"	"	Maria marble	3	Grand Haven, N. Y.		"
3699	"	"	Building stone	4	Burlington, Vt.		"
3700	"	"	Black marble	2	Glen Falls, N. Y.		"
3701	"	"	Brandon marble	2	Brandon, Rutland Co., Vt		" (Goodell quarry)
3702	"	"	Marble	3	" " "		" Trojan Marble Co.
3703	"	"	Brandon statuary marble	2	" " "		" Goodell quarry
3704	"	"	Laponto	1	Lake Lamotte, Grand Isle Co., Vt.		"
3705	"	"		1	Brandon, Rutland Co., Vt		" (Goodell quarry)
3706	"	"	Lignite	1	" " "		"
3707	"	"	Lignite ore	1	" " "		"
3708	"	"	Kaolin (unwashed)		" " "		"
3709	"	"	Kaolin (washed)		" " "		"
3710	"	"	Gypsum (used as land dressing)		Nova Scotia		"
3711	"	"	Graphite	1	Caledonia Co., Vt.		"
3712	"	"	Scythe stone	2	Northfield, Washington Co., Vt.		"
3713	"	"	Granite	2	McViele, Caledonia Co. Vt.		"
3714	"	"	Granite	1	Berlin, Wash. Co., Vt.		"
3715	"	"	Granite	1	Cabot, Caledonia Co., Vt.		" ..[State house is b'lt
3716	"	"	Barre Granite	3	Barre, Wash. Co., Vt.		" Stone from which Vt
3717	"	"	Woodbury granite	2	Woodbury, Washington Co., Vt.		"
3718	"	"	Granite	2	Calais, Wash. Co., Vt.		" From a boulder
3719	"	"	Slate	2	Northfield, Wash. Co., Vt		"
3720	"	"		2	Calais, Wash. Co., Vt.		"
3721	"	"	Verde antique	4	Roxbury, Wash. Co., Vt.		"
3722	"	"		8	Plainfield, Wash. Co., Vt.		"

3723	July, 1880	Geol. [illegible]	....	2	Elmore, Lamoile Co., Vt	....	S. F. Heath..................
3724	"	"	Building stone....................	1	Isle Lamotte, Vt........	....	"
3725	"	"	....	1	Woodbury, Wash. Co., Vt	....	" From top of Wood-
3726	"	"	....	1	" " "	....	" ....[bury Mt.
3727	"	"	....	8	" " "	....	" ....
3728	"	"	Castoroides Ohioensis (Foster)....................	1	Minneapolis............	Drift.......	N. H. Winchell. Lower left ramus and incisor...........
3729	Aug., 1888	"	Granular quartzyte pebble....................	1	Ten-mile Lake, Big Stone Co..........	Drift.......	From E. R. Harkness (banded with iron)...............
3730	"	"	Pressed brick (red)............................	1	St. Louis, Mo..........	....	N. H. W. (Tabernacle Church)
3731	"	"	Resembles *Strophomena incrassata* (H.)..........	1	St. Paul................	Hud. Riv..	N. H, W. Interior of dorsal valve......................
3732	Oct., 1880	"	*Strophomena alternata* (Con.)......................	3	Spring Valley..........	Galena	N. H. W. (=275)................
3733	Mch, 1880	"	*Hemipronites filitextus* (H.).........................	5	Minneapolis............	Trenton....	H. V. Winchell (casts of interior of entering valve.......
3734	"	"	*Hemipronites fili[illegible]tus*	3	Minneapolis............	Trenton....	H. V. W. (perfect casts of interior of both valves).......
3735	Apr., 1880	"	*Hemipronites [illegible]umbonus* (H.)................	1	Kenyon, Goodhue Co...	Hud. Riv..	N. H. Winchell (ventral valve)

ZOOLOGICAL ACCESSIONS TO THE MUSEUM.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
1	....	Cervus canadensis, Erx	M.	Black Hills, Da.	M'td.	N. H. Winchell.	Aug., 1874	Aug., 1874	Geol. & N. H. Sur.	1	Custer Exp.
2	....	Ursus horribilis, Ord	F.	"	"	"	"	"	"	1	"
3	....	Antilocapra americana, Ord	M.	"	"	"	"	"	"	1	"
4	....	Antilocapra americana, Ord	M.	"	"	"	"	"	"	1	"
5	....	Antilocapra americana, Ord	F.	"	"	"	"	"	"	1	"
6	....	Cervus leucurus, Doug	M.	"	"	"	"	"	"	1	"
7	....	Cervus leucurus, Doug	F.	"	"	"	"	"	"	1	"
8	....	Cervus macrotis, Say	M.	"	"	"	"	"	"	1	" Young
9	....	Taxidea americana, Bd	....	"	"	"	"	"	"	1	"
10	....	Alce americanus, Jordine	M.	Otter Tail Co., Mn.	"	Peter Young	Dec., 1874	....	"	1	....
11	....	Lepus calotis, Wagler (?)	....	Currie, Minn.	"	C. L. Herrick	Oct., 1877	Oct., 1877	"	1	....
12	....	Arctomys monax, (L.) Gm	....	....	"	....	....	....	....	1	....
13	....	Procyon lotor, (L.) Storr	....	Lake Minnetonka.	"	C. L. Herrick	July, 1875	July, 1876	Geol. & N. N. Sur.	1	....
14	....	Erethizon dorsatus, (L.) F. Cuv	....	Lake Superior	"	N. H. Winchell.	1879	1879	"	1	....
15	....	Rangifer caribou, Aud. & Bach	....	Lake Superior	"	....	1876	....	N. Butler	1	Presented
16	....	Lynx rufus, (Guld.) Raf	....	New Ulm	Skin	B. Juni	1879	1879	B. Juni	1	....
17	....	Putorius vison, Gapper	....	Lake Superior	M'td.	N. H. Winchell.	1878	1878	Geol. & N. H. Sur.	1	Purchased
18	....	Mustela americana, Turton	....	"	"	"	1878	1878	"	2	"
19	....	Lutra canadensis, Sabine	....	"	"	"	1878	1878	"	1	"
20	....	Mustela pennantii, Erx	....	"	"	"	1878	1878	"	1	"
21	....	Blarina brevicaudata, (Say.) Bd. ?	....	Minneapolis	"	H. V. Winchell.	1878	1878	H. V. Winchell	1	....
22	....	....	....	Black Hills, Da.	"	....	....	1877	Mr. Howling	1	Chinchilla
23	....	Geomys bursarius, (Shaw) Rich	....	Minneapolis	"	H. V. Winchell	1878	1878	H. V. Winchell	1	....
24	....	Spermophilus franklini, (Sab.) Rich	....	"	"	"	1878	1878	"	1	....
25	....	Castor fiber, L.	M.	Lake Superior	"	N. H. Winchell	1879	1879	Geol. & N. H. Sur.	1	Purchased
26	....	Castor fiber, L.	F.	"	"	"	1879	1879	"	1	"
27	....	Sciurus hudsonicus, Pallas	M.	Devils Track L.	kin	T. S. Roberts	Aug. 16, '79	Aug. 16, '79	"		....
28	....	Tamias quadrivittatus, (Say.) Wag.	....	Devil's Track L.	"	"	Aug. 21, '79	Aug. 21, '79	"	1	Variable
29	....	Tamias quadrivittatus, (Say.) Wag.	....	Duluth	"	"	Sep. 1, 1879	Sep. 1, 1879	"	1	"
30	....	Tamias quadrivittatus, (Say.) Wag.	....	Grand Marais	"	"	Aug. 21, '79	Aug. 21, '79	"	1	"
31	....	Tamias quadrivittatus, (Say.) Wag.	....	"	"	"	Aug. 10, '79	Aug. 10, '79	"	1	"
32	....	Tamias quadrivittatus, (Say.) Wag.	....	"	"	"	Aug. 10, '79	Aug. 10, '79	"	1	"
33	....	Tamias quadrivittatus, (Say.) Wag.	....	Duluth	"	"	Sep. 1, 1879	Sep. 1, 1879	"	1	"

34	....	Tamias striatus, (L.) Bd	....		Skin	T. S. Roberts				1	
35	....	Hesperomys eucopus (?)	M.	Poplar R. and S.	"	T. S. Roberts	Aug. 6, 1879	Aug. 6, 1879	Geol. & N. H. Sur.	1	
36	....	Sciurus hudsonicus, Pal	....	Minneapolis	M'td	C. L. Herrick	July, 1876	July, 1876	"	1	
37	....	Sciurus hudsonicus, Pal	....	"	"	"	"	"	"	1	
38	....	Tamias striatus, (L.) Pal	....	"	"	"	"	"	"	1	
39	....	Sciurus carolinensis, Auct	....	"	"	"	"	"	"	1	
40	....	Spermophilus tridecem-lineatus, Mitch	....	"	"	"	"	"	"	1	
41	....	Sciurus carolinensis, Auct	....	"	Skin	"	1876	1877	C. L. Herrick	1	Presented
42	....	Tamias striatus, (L.) Bd	....	"	"	"	1876	1877	"	1	"
43	....	Geomys bursarius, (Shaw.) Rich	....	"	"	"	1877	1877	"	1	"
44	....	Hesperomys michiganensis, And. & Bach.) Wag. ?	....	"	M'td	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	
45	....	Canis familiaris grajus hibernicus, Gm	M.	"	"	E. S. Williams	1879	1879	Mr. Williams	....	Greyhound of
46	....	Vespertilio subulatus, Say	....	Beaver Bay	Alc'hol	N. H. Winchell	1879	1879	Geol. & N. H. Sur.	....	..[Gen. Custer
47	....	Mus (?)	....		"						
48	....	Vespertilio subulatus, Say	....	Grand Marais	"	C. W. Hall	1879	1879	Geol. & N. H. Sur.	1	
49	....	Vespertilio subulatus, Say	....	"	"	"	1879	1879	"	1	
50	....	Turdus migratorius, L	....	Minneapolis	Skin	C. L. Herrick	May, 1875	1876	C. L. Herrick	1	Presented
51	....	Harporhynchus rufus, Cab	....	"	"	"	Aug., 1876	Aug. 20, '76	Geol. & N. H. Sur.	1	
52	....	Hylocichla swainsoni	....	"	"	"	May 14, '75	1876	C. L. Herrick	1	Presented
53	....	Galeoscoptes carolinenisis, (L.) Cab	M.	"	"	"	May 14, '75	1876	"	1	"
54	....	Sialia sialis, (L.)	M.	"	"	"	1877	1877	Geol. & N. H. Sur.	1	
55	....	Regulus satrapa, Licht	F.	S. W. Minnesota	"	"	Oct., 1877	Oct., 1877	"	1	
56	....	Parus atricapillus, L	....	Minneapolis	"	"			"	1	
57	....	Sitta carolinensis, Gm	M.	"	"	"	Aug. 12, '76	Aug. 12, '76	"	1	
58	....	Sitta carolinensis, Gm	....	"	"	"	Feb., 1877	Feb., 1877	"	1	
59	....	Sitta carolinensis, Gm	....	"	"	"	July 24, '76	July 24, '76	"	1	
60	....	Sitta canadensis, Bd	M.	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
61	....	Troglodytes aedon, var.? Coues	M.	"	"	"	May 22, '75	1876	C. L. Herrick	1	Presented
62	....	Cestothorus stellaris, Cab	....	"	"	"	June 21, '71	June 21, '77	Geol. & N. H. Sur.	1	
63	....	Erenophila alpestris, Boie	....	"	"	"	M'ch 31, '75	1876	C. L. Herrick	1	Presented
64	....	Eremophila alpestris, Boie	M.	"	"	"	Feb. 26, '78	Feb. 26, '78	"	1	"
65	....	Mniotilla varia, Vieill	M.	"	"	"	Aug. 16, '76	Aug. 16, '76	Geol. & N. H. Sur.	1	
66	....	Mniotilla varia, Vieill	....	"	"	"	"	"	"	1	
67	....	Mniotilla varia, Vieill	....	"	"	"	"	"	"	1	
68	....	Seiurus aurocapillus, Sw	M.	"	"	"	Aug. 20, '76	Aug. 20, '76		1	
69	....	Seiurus auricapillus, Sw	M.	"	"	"	May 15, '75	1876	C. L. Herrick	1	Presented
70	....	Seiurus novemboracensis, Sw	....	"	"	"	Aug. 14, '76	Aug. 14, '76	Geol. & N. H. Sur.	1	
71	....	Dendrœca aestiva, Bd	M.	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
72	....	Dendrœca aestiva, Bd	....	"	"	"	May 7, 1875	1876	C. L. Herrick	1	Presented
73	....	Dendrœca aestiva, Bd	M.	"	"	"	Aug. 14 '76	Aug. 14, '76	Geol. Survey	1	
74	....	Dendrœca coronata, Gray	....	"	"	"	Apr., 1878	Apr., 1878	C. L. Herrick	1	Presented
75	....	Dendrœca coronata, Gray	....	"	"	"	May 15, '75	1876	"	1	"
76	....	Dendrœca coronata, Gray	....	"	"	"	1876	1876	Geol. Survey	1	
77	....	Dendrœca pennsylvanica, (L.) Bd	M.	"	"	"	July 4, 1877	July 4, 1877	Geol. & N. H. Sur.	1	
78	....	Dendrœca virens, (Gm.) Bd	F.	"	"	"	May 24, '77	May 24, '77	C. L. Herrick	1	Presented

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number	NAME.	Sex	Locality.	Nature of Specimens.	Collected by	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
79	....	Dendrœca palmarum, (Gm.) Bd	....	Minneapolis	Skin	C. L. Herrick	May 4, 1878	May 4, 1878	C. L. Herrick	1	Presented
80	....	Setophaga ruticilla, (L.) Sw	M.	"	"	"	Aug. 20, '76	Aug. 20, '76	Geol. & N. H. Sur.	1	
81	....	Setophaga ruticilla, (L.) Sw	....	"	"	"	Aug. 15, '76	Aug. 15, '76	"	1	
82	....	Setophaga ruticilla, (L.) Sw	....	"	"	"	Aug. 20, '76	Aug. 20, '76	"	1	
83	....	Pyranga rubra, (L.) Vieill	M.	"	"	"	Aug. 19, '76	Aug. 19, '76	"	1	
84	....	Tachycineta bicolor, (Vieill) Cones	M.	L. Minnetonka	"	"	Aug. 4, 1876	Aug. 4, 1876	"	1	
85	....	Progne subis, Bd	M.	Minneapolis	"	"	June 1, 1875	1876	C. L. Herrick	1	Presented
86	....	Ampelis cedrorum, (Vieill) Bd	M.	"	"	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	
87	....	Ampelis cedrorum, (Vieill) Bd	F.	"	"	"	Apr., 1877	1877	C. L. Herrick	1	Presented
88	....	Ampelis cedrorum, (V.) Bd	....	"	"	"	Apr. 18, '77	1877	"	1	"
89	....	Ampelis cedrorum, (V.) Bd	M.	"	"	"	1875	1876	"	1	"
90	....	Vireo olivacea, L	M.	"	"	"	July 19, '76	July 19, '76	Geol. & N. H. Sur.	1	
91	....	Vireo olivacea, L	M.	"	"	"	June 20, '78	June 20, '78	"	1	
92	....	Vireo gilous, Vieill	M.	"	"	"	Aug. 11, '76	Aug. 11, '76	"	1	
93	....	Vireo flavifrous, Vieill	....	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
94	....	Vireo philadelphicus, Cas	....	"	"	"	"	"	"	1	
95	....	Vireo philadelphicus, Cas	....	"	"	"	Aug. 20, '76	Aug. 20, '76	"	1	
96	....	Collurio borealis, Bd	M.	S. W. Minnesota	"	"	Oct., 1877	Oct., 1877	"	1	Young
97	....	Collurio borealis, Bd	M.	"	"	"	"	"	"	1	
98	....	Collurio ludovicianus, L	....	Minneapolis	"	"	1875	1875	C. L. Herrick	1	Presented
99	....	Collurio ludovicianus, L	M.	"	"	"	Aug., 1876	Aug., 1876	Geol. & N. H. Sur.	1	
100	....	Collurio ludovicianus, L	....	"	"	"	July 20, '76	July 20, '76	"	1	
101	....	Pinecola enucleator, (L.) Vieill	M.	"	"	"	M'ch 6, '75	1876	C. L. Herrick	1	Presented
102	....	Chrysomitris tristis, (L.) Bon	M.	Champlin	"	"	June 18, '75	1876	"	1	"
103	....	Chrysomitris tristis, (L.) Bon	M.	....	"	"	Nov. 26, '75	1876	"	1	"
104	....	Plectrophanes nivalis, Meyer	M.	Minneapolis	"	"	Nov. 30, '76	Nov. 1876	"	1	"
105	....	Plectrophanes nivalis, Meyer	F.	"	"	"	"	"	"	1	"
106	....	Plectrophanes lapponicus,(L.) Selby	....	S. W. Min., prairie	"	"	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	
107	....	Plectrophanes lapponicus,(L.) Selby	....	Minneapolis	"	"	1879	1879	C. L. Herrick	1	Presented
108	....	Aegiothus linaria, (L.) Cab	....	"	"	"	1875	1876	"	1	"
109	....	Poœcetes gramineus, (Gm.) Bd	M.	"	"	"	Aug., 1876	Aug., 1876	Geol. & N. H. Sur.	1	
110	....	Poœcetes gramineus, (Gm.) Bd	....	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
111	....	Poœcetes gramineus, (Gm.) Bd	....	"	"	"	Apr., 1877	Apr., 1877	C. L. Herrick	1	Presented

112	....	Ammodromus passerinus, (Wils.) Bd	M.	Minneapolis	Skin	C. L. Herrick	May, 1875	1876	C. L. Herrick	1	Presented
113	....	Ammodromus passerinus, (Wils.) Bd	F.	"	"	"	July 16, '77	July 16, '77	Geol. & N. H. Sur.	1	....
114	....	Passerculus savanna, (Wils.) Bon	....	"	"	"	June 21, '77	June 21, '77	"	1	....
115	....	Ammodromus lecontei, (And.) Bd	M.	"	"	"	"	"	"	1	....
116	....	Ammodromus lecontei, (And.) Bd	M.	"	"	"	"	"	"	1	Young
117	....	Chondestes grammaca, (Say.) Bon	M.	"	"	"	1875	1876	C. L. Herrick	1	Presented
118	....	Chondestes grammaca, (Say.) Bon	....	"	"	"	1875	1876	"	1	"
119	....	Chondestes grammaca, (Say.) Bon	M.	"	"	"	May 5, 1877	1877	"	1	"
120	....	Chondester grammaca, (Say.) Bon	....	"	"	"	"	1877	"	1	"
121	....	Spizella monticola, (Gm.) Bd	....	"	"	"	....	1877	"	1	"
122	....	Spizella monticola, (Gm.) Bd	....	"	"	"	....	....	"	1	"
123	....	Spizella monticola, (Gm.) Bd	....	"	"	"	....	....	"	1	"
124	....	Spizella monticola, (Gm.) Bd	M.	"	"	"	Oct. 9, 1878	1878	"	1	"
125	....	Spizella pallida, (Sw.) Bon	....	"	"	"	May 7, 1875	1876	"	1	"
126	....	Spizella pallida, (Sw.) Bon	....	"	"	"	....	....	Geol. & N. H. Sur.	1	....
127	....	Spizella pallida, (Sw.) Bon	....	"	"	"	Aug., 1876	Aug., 1876	"	1	....
128	....	Spizella socialis, (Wils.) Bon	M.	"	"	"	Aug. 14, '76	Aug. 14, '76	"	1	....
129	....	Melospiza melodea, (Wils.) Bd	M.	"	"	"	1875	1876	C. L. Herrick	1	Presented
130	....	Melospiza melodea, (Wils.) Bd	....	"	"	"	Aug. 12, '76	Aug. 12, '76	Geol. & N. H. Sur.	1	....
131	....	Melospiza palustris, (Wils.) Bd	....	"	"	"	Apr. 31, '77	1877	C. L. Herrick	1	Presented
132	....	Melospiza palustris, (Wils.) Bd	....	L. Minnetonka	"	"	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	....
133	....	Junco hyemalis, (L.) Scl	M.	Minneapolis	"	"	April, 1877	1877	C. L. Herrick	1	Presented
134	....	Junco hyemalis, (L.) Scl	....	"	"	"	Oct. 9, 1876	Oct., 1876	"	1	"
135	....	Passerella iliaca, Sw	....	"	"	"	1875	1878	"	1	"
136	....	Passerella iliaca, Sw	....	"	"	"	....	....	"	1	"
137	....	Passerella iliaca, Sw	....	"	"	"	Sept. 17, '77	1877	"	1	"
138	....	Euspiza americana, Bon	M.	"	"	"	1877	1877	Geol. & N. H. Sur.	1	....
139	....	Goniaphea ludoviciana, Bowd	....	"	"	"	June 5, 1875	1876	C. L. Herrick	1	Presented
140	....	Goniaphea ludoviciana, Bowd	M.	"	"	"	"	1876	"	1	"
141	....	Goniaphea ludoviciana, Bowd	F.	"	"	"	1876	1876	Geol. & N. H. Sur.	1	....
142	....	Cyanospiza cyanea, (L.) Bd	M.	"	"	"	....	....	"	1	....
143	....	Cyanospiza cyanea, (L.) Bd	M.	"	"	"	July, 1876	July, 1876	"	1	....
144	....	Cyanospiza cyanea, (L.) Bd	M.	"	"	"	July 8, 1878	July, 1878	C. L. Herrick	1	Presented
145	....	Pipilo erythrophthalmus, (L.) Vieill.	M.	"	"	"	Aug. 3, 1876	Aug. 3, 1876	Geol, & N. H. Sur.	1	....
146	....	Pipilo erythrophthalmus, (L.) Vieill.	....	"	"	"	....	....	"	1	....
147	....	Dolichonyx oryzivorus, Sw	M.	"	"	"	July 20, '76	July 20, '76	"	1	....
148	....	Ægelæus phœniceus, (L.) V	F.	"	"	"	June, 1875	1876	C. L. Herrick	1	Presented
149	....	Ægelæus phœniceus, (L.) V	M.	"	"	"	Aug. 4, 1876	Aug. 4, '76	Geol. & N. H. Sur.	1	....
150	....	Xanthocephalus icterocephalus, (Bon.) Bd		....	"	"	....	....	....	1	....
151	....	Sternella magna, (L.) Sw	M.	Minneapolis	"	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	....
152	....	Icterus baltimore, (L.) Bon	M.	"	"	"	May 22, '75	1876	C. L. Herrick	1	Presented
153	....	Icterus spurius, (L.) Bon	M.	"	"	"	May 15, '75	1876	"	1	"
154	....	Icterus spurius, (L.) Bon	M.	"	"	"	"	1876	"	1	" Young
155	....	Icterus spurius, (L.) Bon	F.	"	"	"	July, 1876	July, 1876	Geol. & N. H. Sur.	1	....
156	....	Corvus americanus, And	....	Green Isle	"	"	Oct., 1877	Oct., 1877	"	1	....
157	....	Cyanurus cristatus, (L.) Sw	....	"	"	"	July 20, '77	July 20, '77	"	1	....
158	....	Tyrannus carolinensis, (L.) Bd	M.	"	"	"	May 14, '75	1876	C. L. Herrick	1	Presented

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
159	....	Contopus virens, (L.) Cab.	M.	Minneapolis	Skin	C. L. Herrick	Aug. 11, '76	Aug. 11, '76	Geol. & N. H. Sur.	1	
160	....	Contopus virens, (L.) Cab.	....	"	"	"	Aug. 15, '76	Aug. 15, '76	"	1	
161	....	Contopus virens, (L.) Cab.	....	"	"	"	July, 1876	July, 1876	"	1	
162	....	Contopus virens, (L.) Cab.	M.	"	"	"	Aug. 5, 1876	Aug. 5, 1876	"	1	
163	....	Empidonax minimus, Bd.	M.	"	"	"	June 13, '78	June 13, '78	"	1	
164	....	Antrostomus vociferus, (Wils.) Bon.	....	"	"	"	July, 1876	July, 1876	"	1	
165	....	Chordeiles virginianus, Bon.	M.	"	"	"	Aug. 16, '76	Aug. 16, '76	"	1	
166	....	Chætura pelagica, Bd.	M.	"	"	"	July 10, '76	July 10, '76	"	1	
167	....	Trochilus colubris, L.	....	"	"	"	1877	1877	C. L. Herrick	1	Presented
168	....	Ceryle alcyon, Boie	....	"	"	"	Aug. 1, 1876	Aug. 1, 1876	Geol. & N. H. Sur.	1	
169	....	Coccygus erythophthalmus, Bd.	M.	"	"	"	July 17, '78	July 17, '78	"	1	
170	....	Coccygus erythophthalmus, Bd.	F.	"	"	"	June 5, 1875	1876	C. L. Herrick	1	Presented
171	....	Picus pubescens, L.	M.	"	"	"	Aug. 14, '76	Aug. 14, '76	Geol. & N. H. Sur.	1	
172	....	Picus pubescens, L.	M.	"	"	"	Aug. 18, '76	Aug. 18, '76	"	1	
173	....	Picus pubescens, L.	....	"	"	"	....	....	....	1	
174	....	Sphyrapicus varius (L.) Bd.	M.	Champlin	"	"	July 5, 1875	1876	C. L. Herrick	1	Presented
175	....	Melanerpes erythrocephalus, (L.) Sw	M	Minneapolis	"	"	Aug. 28, '76	Aug. 28, '76	Geol. & N. H. Sur.	1	
176	....	Melanerpes erythrocephalus, (L.) Sw	M.	"	"	"	"	"	"	1	Young
177	....	Colaptes auratus, (L.) Sw.	....	"	"	"	Apr. 29, '75	1876	C. L. Herrick	1	Presented
178	....	Colaptes auratus, (L.) Sw.	M.	"	"	"	Aug. 28, '76	Aug. 28, '76	Geol. & N. H. Sur.	1	
179	....	Bubo virginianus, (Gm.) Bon.	....	"	"	"	Nov., 1876	Nov., 1876	C. L. Herrick	1	Presented
180	....	Falco sparverius, L.	....	"	"	"	Aug. 2, 1876	Aug. 2, 1876	Geol. & N. H. Sur.	1	
181	....	Falco sparverius, L.	....	"	"	"	Aug. 13, '75	1876	C. L. Herrick	1	Presented
182	....	Buteo borealis, (Gm.) Vieil (?)	....	S. W. Minnesota	"	"	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	
183	....	Buteo pennsylvanicus, (Wils.) Bon.	M.	Minneapolis	"	"	July 8, 1878	July 8, 1878	"	1	
184	....	Ectopistes migratorius, Sw.	....	"	"	"	July 11, '76	July 11, '76	"	1	
185	....	Ectopistes migratorius, Sw.	M.	"	"	"	July, 1876	July, 1876	"	1	
186	....	Bonasa umbellus, (L.) Steph.	....		"	"	"	"	"	1	
187	....	Bonasa umbellus, (L.) Steph	....	S. W. Minnesota	"	"	Oct., 1877	Oct., 1877	"	1	
188	....	Aegialitis vociferus, L.	....	Minneapolis	"	"	July 22, '76	July 22, '76	"	1	
189	....	Aegialitis vociferus, L.	....	"	"	"	July 19, '78	July 19, '78	"	1	
190	....	Macrochampus griseus, (Gm.) Leach	....	Currie, Minn	"	"	Oct., 1877	Oct., 1877	"	1	
191	....	Totanus solitarius, Wils.	M.	Minneapolis	"	"	Aug. 12, '76	Aug. 12, '76	"	1	

192	....	Totanus solitarius, Wils.	....	Minneapolis	Skin	C. L. Herrick	Aug. 20, '76	Aug. 20, '76	Geol. & N. H. Sur.	1	....
193	....	Totanus solitarius, Wils.	M.	"	"	"	Aug. 12, '76	Aug. 12, '76	"	1	....
194	....	Tringoides macularius, (L.) Gray	M.	"	"	"	July 14, '76	July 14, '76	"	1	....
195	....	Tringoides macularius, (L.) Gray	....	"	"	"	Oct. 4, '76	Oct. 4, 1876	"	1	....
196	....	Actiturus bartramius, (Wils.) Bon.	F.	"	"	"	June 12, '76	June 12, '76	"	1	....
197	....	Actiturus bartramius, (Wils.) Bon.	....	"	"	"	Aug. 6, 1875	1876	C. L. Herrick	1	Presented
198	....	Ardea herodias, (Bt.) Coues	....	L. Minnetonka	"	"	Aug., 1878	Aug., 1878	Geol. & N. H. Sur.	1	....
199	....	Botaurus mugitans, (Bt.) Coues	....	Minneapolis	"	"	1875	1876	C. L. Herrick	1	Presented
200	....	Porzana carolina, (L.) V.	....	"	"	"	Aug. 20, '76	Aug. 20, '76	Geol. & N. H. Sur.	1	....
201	....	Fulica americana, Gm.	....	Currie, Murray Co.	"	"	Oct., 1877	Oct., 1877	"	1	....
202	....	Fulica americana, Gm.	....	"	"	"	"	"	"	1	....
203	....	Anser hyperboreus Pallas	....	"	"	"	"	"	"	1	....
204	....	Aix sponsa, (L.) Boie	M.	"	"	"	"	"	"	1	....
205	....	Querquedula discors, (L.) Steph.	....	"	"	"	"	"	"	1	....
206	....	Fuligula ferina, var. americana, Eyton	M.	"	"	"	"	"	"	1	....
207	....	Fuligula ferina, var. americana, Eyton	....	"	"	"	"	"	"	1	....
208	....	Fulignia ferina, var. americana, Eyton	F.	"	"	"	"	"	"	1	....
209	....	Fuligula ferina, var. americana, Eyton	F.	"	"	"	"	"	"	1	....
210	....	Spatula clypeata, (L) Boie	F.	"	"	"	"	"	"	1	....
211	....	Mareca americana, (Gm.) Steph.	F.	"	"	"	"	"	"	1	....
212	....	Chaulelasmus streperus, (L.) Gray	F.	"	"	"	"	"	"	1	....
213	....	Anas boschas, L.	M.	"	"	"	"	"	"	1	....
214	....	Lophodytes cucullatus, (L.) Rich.	....	Minneapolis	"	"	Nov., 1877	Nov., 1877	"	1	....
215	....	Graculus dilophus, (Sw.) Gray	....	Currie	"	"	Oct., 1877	Oct., 1877	"	1	....
216	....	Thalasseus caspius, Boie	M.	Long Lake	"	Will. Secomb	Nov., 1877	Nov., 1877	Will. Secomb	1	Presented
217	....	Larus delewarensis, Ord	....	Currie	"	C. L. Herrick	Oct., 1877	Oct., 1877	Geol. & N. H. Sur.	1	Young
218	....	Hydrochelidon lariformis, L.	M.	Minneapolis	"	"	July 19, '76	July 19, '76	"	1	....
219	....	Hydrochelidon lariformis, L.	....	"	"	"	"	"	"	1	Young
220	....	Podilymbus podiceps, (L.) Law.	....	Currie	"	"	Oct., 1877	Oct., 1877	"	1	....
221	....	Bubo virginianus, Bon.	....	L. Minnetonka	"	"	Aug., 1878	Aug., 1878	"	1	Young
222	1	Ampelis cedrorum, Vieill.	M.	Grand Marais	"	T. S. Roberts	July 28, '79	July 28, '79	"	1	....
223	2	Totanus solitarius, Wilson	F.	"	"	"	"	"	"	1	....
224	3	Melospiza melodia, (Wils.) Bd.	M.	"	"	"	"	"	"	1	....
225	4	Tringa minutilla, Vieill.	M.	"	"	"	"	"	"	1	....
226	5	Tringa minutilla, Vieill.	F.	"	"	"	"	"	"	1	....
227	6	Totanus flavipes, Gm.	M.	"	"	"	"	"	"	1	....
228	7	Dendrœca virens, (Gm.) Bd.	F.	"	"	"	"	"	"	1	....
229	8	Totanus solitarius, Wils.	M.	"	"	"	"	"	"	1	....
230	9	Totanus flavipes, Gm.	F.	"	"	"	"	"	"	1	....
231	10	Totanus flavipes, Gm.	M.	"	"	"	"	"	"	1	....
232	11	Chrysomitris pinus, (Wils.) Bon.	M.	"	"	"	July 29, '79	July 29, '79	"	1	....
233	12	Ampelis cedrorum, (Vieill.) Bd.	M.	"	"	"	July 30, '79	July 30, '79	"	1	....
234	13	Ampelis cedrorum, (Vieill.) Bd.	F.	"	"	"	"	"	"	1	....
235	14	Ampelis cedrorum, (Vieill.) Bd.	M.	"	"	"	"	"	"	1	....

Zoological Accessions to the Museum—Continued.

Catelogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
236	15	Zonotrichia albicollis, (Gm.) Bon...	M.	Grand Marais....	Skin...	T. S. Roberts....	July 30, '79	July 30, '79	Geol. & N. H. Sur.	1	....
237	16	Picus pubescens L........	F.	"	" ...	"	"	"	"	1	....
238	17	Ampelis cedrorum, (Vieill) Bd......	....	"	" ...	"	"	"	"	1	....
239	18	Ectopistes migratorius, (L.) Sw.....	M.	"	" ...	"	"	"	"	1	....
240	19	Molothrus ater, (Bodd.) Gray.......	....	"	" ...	"	"	"	"	1	....
241	20	Spizella socialis, (Wils.) Bon........	M.	"	" ...	"	"	"	"	1	....
242	21	Dendrœca maculosa, (Gm.) Bd.....	....	"	" ...	"	"	"	"	1	....
243	22	Trochilus colubris, L..............	....	"	Alc'hol	"			"	1	....
244	23	Loxia curvirostra, L..............	M.	Poplar River......	Skin...	"	Aug. 8, 1879	Aug. 8, 1879	"	1	....
245	25	Myiodioctes canadensis, (L.) Aud...	F.	"	" ...	"	Aug. 4, 1877	Aug. 4, 1879	"	1	....
246	26	Myiodioctes canadensis, (L.) Aud...	....	"	" ...	"	"	"	"	1	....
247	27	Porzana carolina, (L.) V...........	M.	"	" ...	"	Aug. 5, 1879	Aug. 5, 1879	"	1	....
248	28	Zonotrichia albicollis, (Gm.) Bon...	M.	"	" ...	"	"	"	"	1	Young........
249	29	Dendrœca cerulescens, (L.) Bd	M.	"	" ...	"	Aug. 6, 1879	Aug. 6, 1879	"	1	....
250	30	Dendrœca corulescens, (L.) Bd	M.	"	" ...	"	"	"	"	1	....
251	31	Empidonax flaviventris, Bd.........	F.	"	" ...	"	"	"	"	1	....
252	32	Empidonax flaviventris, Bd.........	....	"	" ...	"	"	"	"	1	....
253	33	Dendrœca maculosa, (Gm.) Bd......	....	"	" ...	"	"	"	"	1	....
254	34	Myiodioctes canadensis, (L.) Aud ..	M.	"	" ...	"	"	"	"	1	....
255	35	Parus atricapillus L..........	....	"	" ...	"	Aug. 5, 1879	Aug. 5, 1879	"	1	....
256	36	Dendrœca blackburniæ, (Gm.) Bd..	F.	Grand Marais....	" ...	"	Aug. 9, 1879	Aug. 9, 1879	"	1	....
257	37	Setophaga ruticilla, (L.) Sw........	M.	"	" ...	"	"	"	"	1	....
258	38	Dendrœca blackburniæ, (Gm.) Bd.	F.	"	" ...	"	"	"	"	1	Young........
259	39	Zonotrichia alcicollis, (Gm.) Bon ...	....	"	" ...	"	"	"	"	1	....
260	40	Ectopistes migratorius, (L.) Sw.....	F.	"	" ...	"	"	"	"	1	....
261	41	Loxia curvirostra, L..............	M.	"	" ...	"	Aug. 5, 1879	Aug. 5, 1879	"	1	....
262	42	Loxia curvirostra, L..............	M.	"	" ...	"	Aug. 11, '79	Aug. 11, '79	"	1	....
263	43	Loxia curvirostra, L..............	M.	"	" ...	"	Aug. 12, '76	Aug. 12, '79	"	1	....
264	44	Loxia curvirostra, L..............	F.	"	" ...	"	"	"	"	1	....
265	45	Chrysometris pinus, (Wils.) Bon....	F.	"	" ...	"	"	"	"	1	....
266	46	Larus argentatus, (Wils.) Bon.......	M.	"	" ...	"	"	"	"	1	Young........
267	47	Loxia curvirostra, L..............	M.	"	" ...	"	"	....	"	1	....
268	48	Falco columbarius, L..............	....	"	" ...	"	Aug. 13, '79	Aug. 13, '79	"	1	....

269	49	Coccygus erythrophthalmus (Wil) Bd	M.	Grand Marais....	Skin...	T. S. Roberts....	Aug. 13, '79	Aug. 13, '79	Geol. & N. H. Sur.	1	....
270	50	Helminthophaga peregrina (Wils) Bon.	M.	"	" ...	"	"	"	"	1	....
271	51	Myiodioctes canadensis (L.) And...	....	"	" ...	"	"	"	"	1	....
272	52	Perissoglossa tigrina, (Gen.) Bd.....	....	"	" ...	"	"	"	"	1	....
273	53	Helminthophaga peregrina (Wil) Cab	....	"	" ...	"	"	"	"	1	....
274	54	Dendrœca virens, (Gm.) Bd........	....	"	" ...	"	"	"	"	1	....
275	55	Spizella socialis (Wils.) Bon.........	M.	"	" ...	"	"	"	"	1	....
276	56	Spizella socialis, (Wils.) Bon........	M.	"	" ...	"	"	"	"	1	....
277	57	Melospiza melodia, (Wils.) Bd......	M.	"	" ...	"	Aug. 12, '79	Aug. 12, '79	"	1	....
278	58	Melospiza melodia, (Wils.) Bd......	M.	"	" ...	"	Aug. 13, '79	Aug. 13, '79	"	1	....
279	59	Seiurus nævius (Coues)............	M.	Devils Track Lake	" ...	"	Aug. 10, '79	Aug. 10, '79	"	1	....
280	60	Dendroeca castanea, (Wils.) Bd	F.	"	" ...	"	Aug. 11, '79	Aug. 11, '79	"	1	....
281	61	Dendroeca coronata, (L.) Gray	F.	"	" ...	"	Aug. 16, '79	Aug. 16, '79	"	1	....
282	62	Helminthophaga peregrina (Wil.) Bd	....	"	"	"	"	"	"		
283	63	Bonasa umbellus (L.) Steph....	M.	"	" ...	"	"	"	"	1	....
284	64	Seurus nævius, Cones....	F.	"	" ...	"	"	"	"	1	....
285	65	Seurus nævius, Cones	M.	"	" ...	"	Aug. 18, '79	Aug. 18, '79	"	1	....
286	66	Dendrœca blackburniæ (Gen.) Bd..	M.	"	" ...	"	"	"	"	1	....
287	67	Helminthophaga ruficapilla (Wils) Bd	F.	"	" ...	"	"	"	"	1	....
288	68	Helminthophaga perigrina (Wils) Bd	....	"	" ...	"	"	"	"	1	....
289	69	Loxia curvirostra, L................	F.	Grand Marais....	" ...	"	"	"	"	1	....
290	70	Loxia curvirostra, L................	F.	"	" ...	"	"	"	"	1	....
291	71	Loxia curvirostra, L................	M.	"	" ...	"	"	"	"	1	....
292	72	Troglodytes ædon, Vieill...........	....	"	" ...	"	Aug. 19, '79	Aug. 19, '79	"	1	....
293	73	Aegeleus phœniceus (L.) V..........	F.	"	" ...	"	"	"	"	1	....
294	74	Helminthophaga peregrina (Wils) Bd	....	"	" ...	"	"	"	"	1	....
295	75	Aegeleus phœniceus (L.) V..........	....	"	" ...	"	"	"	"	1	....
296	76	Spizella socialis, (Wils.) Bon........	F.	"	" ...	"	"	"	"	1	....
297	77	Falco sparverius, L.................	F.	"	" ...	"	"	"	"	1	....
298	78	Coccygus erythrophthalmus (Wil) Bd	M.	"	" ...	"	"	"	"	1	....
299	79	Larus delawarensis, Ord............	....	"	" ...	"	"	"	"	1	....
300	80	Buteo pennsylvanicus, (Wils.) Bon.	....	"	" ...	"	"	"	"	1	....
301	81	Falco sparverius, L.................	M.	"	" ...	"	"	"	"	1	....
302	82	Falco sparverius, L.................	M.	"	" ...	"	"	"	"	1	....
303	83	Contopus borealis, (Sw.) Bd.........	....	"	" ...	"	Aug. 20, '79	Aug. 29, '79	"	1	....
304	84	Tyrannus carolinensis (L.) Bd	M.	"	" ...	"	"	"	"	1	....
305	85	Contopus borealis (Sw.) Bd..........	M.	"	" ...	"	"	"	"	1	....
306	86	Sayornis fuscus, (Gen.) Bd	F.	"	" ...	"	"	"	"	1	....
307	87	Empidonax minimus, Bd	F.	"	" ...	"	"	"	"	1	....
308	88	Tyrannus carolinensis, (L.) Bd......	F.	"	" ...	"	"	"	"	1	....
309	89	Contopus borealis, (Sw.) Bd.........	M.	"	" ...	"	"	"	"	1	....

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED. When	OBTAINED. Whence.	No. of Specimens.	Remarks.
310	91	Contopus borealis, (Sw.) Bd	F.	Grand Marais	Skin	T. S. Roberts	Aug. 20, '79	Aug. 20, '79	Geol. & N. H. Sur.	1	
311	92	Contopus borealis, (Sw.) Bd		"	"	"	"	"	"	1	
312	93	Chrysomitris pinus, (Wils.) Bon	M.	"	"	"	"	"	"	1	
313	94	Picus villosus, L	F.	"	"	"	"	"	"	1	
314	95	Picoides arcticus, (Sw.) Gray	F.	"	"	"	Aug. 21, '79	Aug. 21, '79	"	1	
315	96	Bubo virginianus, (Gm.) Bon	F.	"	"	"	Aug. 20, '79	Aug. 20, '79	"	1	
316	97	Helminthophaga perigrina, (Wils) Cab	F.	"	"	"	"	"	"	1	
317	98	Helminthopaga perigrina, (Wils) Cab	F.	"	"	"	"	"	"	1	
318	99	Picus pubescens, L	M.	"	"	"	"	"	"	1	
319	100	Contopus borealis, (Sw.) Bd	M.	"	"	"	"	"	"	1	
320	101	Picus pubescens, L	M.	"	"	"	"	"	"	1	
321	102	Falco sparverius, L	F.	"	"	"	"	"	"	1	
322	103	Anas boschas, L	F.	Devil's Track R	"	"	"	"	"	1	
323	104	Trigan semipalmata	F.	"	"	"	Aug. 21, '79	Aug. 21, '79	"	1	
324	105	Ampelis cedrorum, (Vieill.) Bd	F.	"	"	"	"	"	"	1	
325	106	Tringa bairdii, (?)		Grand Marais	"	"	Aug. 22, '79	Aug. 22, '79	"	1	
326	107	Tringa bairdii, (?)	F.	"	"	"	"	"	"	1	
327	108	Loxia curvirostra, L	M.	"	"	"	Aug. 23, '79	Aug. 23, '79	"	1	
328	109	Loxia curvirostra, L	F.	"	"	"	"	"	"	1	
329	111	Myiodioctes pusillus, (Wils.) Bon	M.	Beaver Bay	"	"	Aug. 27, '79	Aug. 27, '79	"	1	
330	112	Empidonax traillii, (And.) Bd		"	"	"	"	"	"	1	
331	113	Dendrœca striata, (Forst.) Bd	F.	"	"	"	"	"	"	1	
332	114	Helminthophaga ruficapilla, (Wils.) Bd		"	"	"	"	"	"	1	
333	115	Dendrœca palmarum, (Gm.) Bd	F.	"	"	"	"	"	"	1	
334	116	Dendrœca maculosa, (Gm.) Bd		"	"	"	"	"	"	1	
335	117	Helminthopaga peregrina, (Wils) Cab		"	"	"	"	"	"		
336	118	Porzana carolina, L		"	"	"	"	"	"	1	
337	119	Astor palumbarius, L., var. atricapillus, (Wils.) Coues		Little Marais	"	"	Aug. 26, '79	Aug. 26, '79	"	1	Young of the year

338	120	Helminthophaga ruficapilla (Wil.) Bd.	....	Beaver Bay......	Skin...	T. S. Roberts....	Aug. 28, '79	Aug. 28, '79	Geol. & N. H. Sur.	1	....
339	121	Vireosylvia olivacea, (L.) Bon......	....	"	" ...	"	"	"	"	1	....
340	122	Lobipes hyperboreus (L.) Cur.......	F.	Near Beaver Bay.	" ...	N. H. Winchell.	Aug. 29, '79	Aug 29, '79	"	1	....
341	123	Aegeleus phœniceus (L.) V.........	M.	Beaver Bay.......	" ...	T. S. Roberts....	"	"	"	1	....
342	124	Colaptes auratus, (L.) Sw	F.	Duluth, Minn.....	" ...	"	Sept. 1, 1879	Sept. 1, 1879	"	1	....
343	125	Tringordes macularius, (L.) Gray...	....	"	" ...	"	"	"	"	1	....
344	126	Chordeiles virginianus, (Gm.) Bon.	F.	"	" ...	"	"	"	"	1	....
345	127	Corvus americanus..................	M.	"	" ...	"	"	"	"	1	....
346	128	Falco sparverius, L.................	....	"	" ...	"	"	"	"	1	....
347	129	Melospiza melodia, (Wils.) Bd......	....	"	" ...	"	"	"	"	1	....
348	....	Haliaetus leucocephalus (L.) Savigny	....	....	M'td...	....	....	....	"	1	In rustic case
349	....	Buteo borealis (Gm.) Vieill.........	....	Hopkin's Station..	" ...	C. L. Herrick....	July 1876..	July, 1876..	"	1	"
350	....	Falco sparverius, L..................	....	Minneapolis	" ...	"	" ..	" ..	"	1	"
351	....	Corvus corax, L......................	....	"	" ...	N. Herrick.....	" ..	" ..	"	....	"
352	....	Dolichonyx oryzivorus, (L.) Sw	M.	"	" ...	B. L. Herrick...	" ..	" ..	"	....	"
353	....	Dolichonyx oryzivorus	F.	"	" ...	"	" ..	" ..	"	....	"
354	....	Botarus mugitans, (Bart.) Coues....	....	"	" ...	"	" ..	" ..	"	....	"
355	....	Tringoides macularius, (L.) Gray...	....	"	" ...	"	" ..	" ..	"	....	"
356	....	Totanus solitarius, Wils............	....	"	" ...	"	" ..	" ..	"	....	"
357	....	Scolopax rusticola, L...............	....	"	" ...	"	" ..	" ..	"	....	"
358	....	Sturnella magna, (L.) Sw	....	"	" ...	"	" ..	" ..	"	....	"
359	....	Melothrus ater, (Bodd.) Gray.......	M.	"	" ...	"	" ..	" ..	"	....	"
360	....	Seiurus auricapillus, (L.) Sw.......	....	"	" ...	"	" ..	" ..	"	....	"
361	....	Vireosylvia olivacea, (L.) Bon......	....	"	" ...	"	" ..	" ..	"	....	"
362	....	Helminthophaga ruficapilla (?).....	....	"	" ...	"	" ..	" ..	"	....	"
363	....	Cotyle riparia, (L.) Boie...........	....	"	" ...	"	" ..	" ..	"	....	"
364	....	Melospiza melodia, (Wils.) Bd......	....	"	" ...	"	" ..	" ..	"	....	"
365	....	Melanerpes erythrocephalus (L.) Sw	....	"	" ...	"	" ..	" ..	"	....	"
366	....	Colaptes auratus, (L.) Sw	....	"	" ...	"	" ..	" ..	"	....	"
367	....	Chætura pelagica, (L.) Sw...........	....	"	" ...	"	" ..	" ..	"	....	"
368	....	Hydrochelidon lariformis (L) Coues	....	"	" ...	"	" ..	" ..	"	....	"
369	....	Spizella pallida, (Sw.) Bon..........	....	"	" ...	"	" ..	" ..	"	....	"
370	....	Seiurus aurocapillus,(L.) Sw....	....	"	" ...	"	" ..	" ..	"	....	"
371	....	Vireosylvia olivacea, (L.) Bon	....	"	" ...	"	" ..	" ..	"	....	"
372	....	Eremophila alpestris, Boie..........	....	"	" ...	"	" ..	" ..	"	....	"
373	....	Poœtes gramineus, (Gray) Bd.......	....	"	" ...	"	" ..	" ..	"	....	"
374	....	Harporhynchus rufus................	....	"	" ...	"	" ..	" ..	"	....	"
375	....	Icterus spurius, (L.) Bon	....	"	" ...	"	1876	1876	"	....	"
376	....	Cyanospiza cyanea, (L.) Bd.........	M.	"	" ...	"	1876	1876	"	....	"
377	....	Tyrannus carolinensis (L.) Bd	....	"	" ...	"	1876	1876		....	"
378	....	Goniaphea ludoviciana (L.) Board..	....	"	" ...	"	1276	1876	"	....	"
379	....	Chordeiles virginianus, (Gm.) Bon.	....	"	" ...	"	1876	1876	"	....	"
380	....	Icterus baltimore, (L.) Dandin	....	"	" ...	"	1876	1876	"	....	"
381	....	Hylocichla swainsoni (Cab) Bd.....	....	"	" ...	"	1876	1876	"	....	"
382	....	Ectopistes migratorius..............	....	"	" ...	"	1879	1876	"	....	"
383	....	Sialia sialis, (L.) Haldeman.........	....	"	" ...	"	1876	1876	"	....	"
384	....	Galeoscoptes carolinensis, (L.) Cab.	....	"	" ...	"	1876	1876	"	....	"

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Numbeo.	NAME.	Sex	Locality	Nature of Specimen.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
385	....	Dendrœca æstiva, (Gm.) Bd.	....	Minneapolis	M'td	C. L. Herrick	1876	1876	Geol. & N. H. Sur.	1	In rustic case,
386	....	Goniaphea ludoviciana, (L.) Bowd.	M.	"	"	"	1876	1876	"	1	"
387	....	Goniaphea ludoviciana, (L.) Bowd.	F.	"	"	"	1876	1876	"	1	"
388	....	Euspiza americana, (Gm.) Bd.	....	"	"	"	1876	1876	"	1	"
389	....	Pyranga rubra, (L.) Vieill.	M.	"	"	"	1876	1876	"	1	"
390	....	Collurio ludovicianus, L.	....	"	"	"	1876	1876	"	1	"
392	....	Ammodromus passerinus, (Wils) Bd.	....	"	"	"	1876	1876	"	1	"
392	....	Aquila chrysætus, L.	....	Grand Marais	"	H. Mayhew	1877	1879	H. Mayhew	1	Presented.
393	....	Podilymbus podiceps	F.	....	"	C. W. Hall	Sept., 1878	1878	Geol. & N. H. Sur.	1	....
394	....	Pelecanus trachyrhynchus, Lath.	M.	....	"	....	....	....	....	1	....
395	....	Pelecanus trachyrhynchus, Lath.	F.	....	"	....	....	....	....	1	....
396	....	Rhinogryphus aura, (L.) Ridg.	F.	Grand Marais	"	C. W. Hall	1878	1878	Geol. & N. H. Sur.	1	....
397	....	Grus canadensis, (L.) Temm.	M.	Medicine Lake	"	E. Moulton	1878	1880	Wm. Howling	1	By purchase.
398	....	Grus canadensis, (L.) Temm.	F.	Lake Minnetonka.	"	P. M. Babcock	1879	1880	"	1	"
399	....	Larus argentatus, Brünn.	....	Grand Marais	"	S. F. Peckham	1879	1879	Geol. & N. H. Sur.	1	....
400	....	Ampelis garrulus, L.	M.	Minneapolis	"	T. S. Roberts	Feb., 1880	1880	T. S. Roberts	1	Presented.
401	....	Ampelis garrulus, L.	F.	"	"	"	"	1880	"	1	"
402	....	Accipiter fuscus, (Gm.) Bon.	M.	Lake Minnetonka.	"	Wm. Howling,	....	May, 3, 1880	Mr. Howling	1	"
403	....	Accipiter fuscus, (Gm.) Bon.	F.	Minneapolis	"	J. W. Pomeroy	Jan., 1880	1880	J. W. Pomeroy	1	....
404	....	Falco sparverius, L.	....	Grand Marais	"	C. W. Hall	Sept., 1878	1878	Geol. & N. H. Sur.	1	....
405	....	Harporhynchus rufus	....	Minneapolis	"	C. L. Herrick	July, 1879	July, 1879	C. L. Herrick	1	By purchase.
406	....	Chordeiles virgineanus, (Gm.) Bon.	F.	"	"	"	"	"	"	1	"
407	....	Coccygus americanus, (L.) Bon.	....	"	"	"	"	"	"	1	"
408	....	Icterus spurius, (L.) Bon.	M.	"	"	"	"	"	"	1	Young.
409	....	Scolecophagus ferrugineus, (Gm) Sw	M.	"	"	"	"	"	"	1	"
410	....	Ceryle alcyon, (L.) Boie.	....	"	"	"	"	"	"	1	"
411	....	Xanthocephalus icterocephalus, (Bon.) Bd.	M.	"	"	"	"	"	"	1	"
412	....	Aegelaeus phœniceus, (L.) V.	M.	"	"	"	"	"	"	1	"
413	....	Colaptes auratus, (L.) Sw.	....	"	"	"	"	"	"	1	"
414	....	Poœtes gramineus, (Gray) Bd.	....	"	"	"	"	"	"	1	"
415	....	Poœtes gramineus, (Gray) Bd.	....	"	"	"	"	"	"	1	"

416	Tongue of dog		Minneapolis	Alc'hol	C. W. Hall	1879	1879	Geol. & N. H. Sur.	1	
417	Larynx and hyoid bone of dog		"	"	"	1879	1879	"	1	
418	Heart and connecting vessels of dog		"	"	"	1879	1879	"	1	
419	Lungs and trachea of dog		"	"	"	1879	1879	"	1	
420	Heart of duck- -billed cat fish		"	"	"	1880	1880	"	1	
421	Gizzard of Bonasa umbellus		"	"	"	1879	1879	"	1	
422	Gizzard of owl		"	"	"	1879	1879	"	1	
423	Heart of lake trout		"	"	"	1879	1879	"	1	
424	Heart of Bonasa umbellus		"	"	"	1879	1879	"	1	
425	Egg of turtle		"	"	N. H. Winchell	1879 (?)	1879 (?)	"	1	
426	Woodpecker's tongue		"	"	C. W. Hall	1879	1879	"	1	
427	Tongue of mallard duck		"	"	"	1879	1879	"	1	
428	Pelican's sterna and trachea		New Ulm	"	Mr. Howling	Apr. 20, '80	Apr. 20, '80	Wm. Howling	2	
429	Humeri ulnæ and tibiæ of pelican		"	"	"	"	"	"	6	
430	Skull of Canis		Minneapolis	Mt'd	C. L. Herrick	1879	1879	C. L. Herrick	1	Presented
431	Skull of Felis		"	"	"	1879	1879	"	1	"
432	Pseudopleuronectes americanus, Gill		Manchester, Mass.	Alc'hol	C. W. Hall	July, 1880	1880	Geol. & N. H. Sur.	2	
433	Eutænia sirtalis, Bd. & G'rd	F.	Minneapolis	"	C. L. Herrick	July, 1879	July, 1879	C. L. Herrick	1	
434	Crotalus horridus, L.		Black Hills, Da.	"	N. H. Winchell	1874	1874	Geol. & N. H. Sur.	1	Custer Exp
435	Pityophis sayi, Bd. & G'rd		"	"	"	1874	1874	"	1	"
436	Eutaenia sirtalis, Bd. & G'rd		"	"	"	1874	1874	"	1	"
437	Eutaenia sirtalis, Bd. & G'rd		Minneapolis	"	"			"	1	
438	Ophibolus doliatus, var. triangulus		"	"	H. V. Winchell	1879	1879	"	1	
439	Aspidenectes spinifer, (Le S.) Ag		"	"	T. S. Roberts	1879	1879	"	1	
440	Tropidonotus, s. p. ?		Lake Minnetonka	"	W. H. Shenton	1880	1880	W. H. Shenton	1	
441	Tropidonotus, (?)		Minneapolis	"	C. L. Herrick	1877	1877	Geol. & N. H. Sur.	1	
442	Liopellis vernalis, Jar		Black Hills, Da.	"	N. H. Winchell	1874	1874	"	2	Custer Exp
443	Chrysemys picta, Ag	F.	Minneapolis	"	C. L. Herrick	1879	1879	C. L. Herrick	1	Viscera exposed
444	Tropidontus sipedon		"	"	"	July, 1877	1877	Geol. & N. H. Sur.	1	
445				"						Turtle
446				"						Turtle
447	Eutænia sirtalis, Bc. & G'rd		Black Hills, Da.	"	N. H. Winchell	1870	1874	Geol. & N. H. Sur.	1	Custer Exp
448	Eutænia sirtalis, Bd. & G'rd		"	"	"	1874	1874	"	2	"
449	Eutænia sirtalis, Bd. & G'rd		Minneapolis	"	C. L. Herrick	July, 1876	July, 1876	"	1	
450	Eutænia, s. p. ?		"	"	H. V. Winchell	Aug., 1880	Aug., 1880	H. V. Winchell		
451	Plathodon erythronotus, (Green) Bd		Grand Marais	"	C. W. Hall	Aug., 1879	Aug., 1879	Geol. & N. H. Sur.	4	
452	Eutænia, s. p. ?		Black Hills, Da.	"	N. H. Winchell	1874	1874	"	1	Custer Exp
453	Bufo lentinginosus, Shaw			"					1	
454	Bufo lentinginosus, Shaw			"					1	
455	Rana clamitans, Merr		Lake Minnetonka	"	C. L. Herrick	Aug., 1878	Aug., 1878	C. L. Herrick	1	
456	Rana halecina, Kalm			"					1	
457	Necturus, s. p ?			"					1	
458	Necturus maculatus		Minneapolis	"	N. H. Winchell			Geol. & N. H. Sur.	1	
459	Rana clamitans, Merr		"	"	C. L. Herrick	1876	1876	"	1	
460	Rana halecina, Kalm		"	"	H. Nachtrieb	1878	1878	N. Nachtrieb	1	
461	Bufo lentiginosus, Shaw		"	"	C. L. Herrick	1877	1877	Geol. & N. H. Sur.	1	
462	Necturus lateralis, Say		"	"	N. H. Winchell			"	1	

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
463		Rana halecina, Kalm		Minneapolis	Alc'hol	C. L. Herrick	1879	1879	C. L. Herrick	1	Alimentary ca-
464		Phrynosoma douglasi, Bell?		Dakota Ter.	"	N. H. Winchell	1874	1874	Geol. & N. H. Sur.	4	..[nal exposed
465		Amblystoma, (s. p. ?)		Minneapolis	"	C. L. Herrick	July, 1876	July, 1876	"	1	Immature
466		Amblystoma punctatum		"	"	N. H. Winchell			"	Ind	
467				California	"	R. O. Sweeny	1880	1880	R. O. Sweeney	1	Horned toad,
468				New Mexico	"	N. H. Winchell	1872		N. H. Winchell	1	" [presentd
469				"	"	"	1872		"	1	"
470				Minnetonka	"	C. L. Herrick	Aug., 1878	Aug., 1878	Geol. & N. H. Sur.	1	Frog
471		Rana halecina, Kalm		Minneapolis	"	H. V. Winchell	Aug., 1880	Aug., 1880	H V, Winchell	1	
472				"	"	"	"	"	"	1	Frog
473		Amblystoma, sp. ?		"	"	"	"	"	"		
474				Black Hills	"	N. H. Winchell	1874	1876	Geol. & N. H. Sur.	1	Custer Exp.
475				California	"	Th. Croswell	1877	1877	Th. Croswell		Horned toad
476		Pimephales promelas, Raf		Minneapolis	"	T. S. Roberts	July 10, '79	July, 1879	T. S. Roberts		
477		Eupomotis aureus, (Walb.) G. & J		"	"	"	July 6, 1879	"	"		
478		Pimephales promelas, Raf		"	"	"	July 10, '79	"	"		
479		Calostomistæ		Grand Marais	"	"			Geol. & N. H. Snr.		Young
480		Salvelinus frontinalis, (Mitch) G.&J		N. shore L. Sup.	"	C. W. Hall	July, 1878	1878	"		
481		Pimephales promelas, Raf		Minneapolis	"	T. S. Roberts	July 10, '79	July, 1879	T. S. Roberts		
482		Boleichthys eos		"	"	"	Apr. 24, '79	"	"		
483		Hyborhynchus notatus		"	"	"	May 9, 1879	"	"		
484				"	"	"					
485		Ceratichthys biguttatus, (Kirk) Grd		"	"	"	June, 1879	July, 1879	T. S. Roberts		
486		Boleichthys eos		"	"	"	Apr. 24, '79	"	"		
487		Potamocottus alvordii, (Grd) Gill (?)		Grand Marais	"	"	Aug., 1879	Aug., 1879	Geol. & N. H. Sur.		
488		Pimephales promelas, Raf		Minneapolis	"	"	July 10, '79	July, 1879	T. S. Roberts		
489		Canutus luxilus, (Mitch.) Jor		"	"	"	Apr. 24, '79	"	"		
490		Fundulus diaphanes		"	"	"	May 1, 1879	"	"	2	
491		Bolesoma maculata, Ag		Basset's Cr., Minne	"	"	July 4, 1879	"	"	6	
492		Pygosteus occidentalis, var. nebulosus, (Ag.) Jor		Grand Marais	"	"	July 29, '79	"	Geol. & N. H. Sur.		
493		Hyodon tergisus, Le Sueur		Minneapolis	"	W. H. Chambers	May 15, '80	1880	W. H. Chambers	2	...[Long Lake
494		Percina manitou, Jor		Ramsey Co.	"	T. S. Roberts	Apr. 28, '79	Apr. 28, '79	T. S. Roberts	2	From a trib. of

495	Stizostethium vitreum, (Mitch) J.& C	Medicine Lake	Alc'hol	T. S. Rhodes	June 30, '79	1879	T. S. Roberts		
496	Pomoxys nigromaculatus, (Le S.) Grd	"	"	"	"	1879	"		
497	Cycleptus elongatus	Minneapolis	"	W. H. Chambers	May 15, '80	1880	W. H. Chambers		
498	Acipenser rubicundus, Le S.	"	"	"	May, 1878	1878	"		
499	Lepiopomus pallidus, (Mitch) G. & J	L. Minnetonka	"	T. S. Roberts	July 8, 1879	1879	T. S. Roberts		
500	Ceratichthys biguttatus, (Kirt) Gird.	Minneapolis	"	"	June 1, 1879	1879	"		
501	Semotilus corporalis, Mitch.	"	"	"	June 28, '79	1379	"		
502	Amiurus melas, (Raf.) J. & C.	"	"	"	"	1879	"		
503	Amiurus melas (Raf.) J. & C.	"	"	"	"	1879	"		
504	Perca americana, Schr.	Medicine Lake	"	"	June 30, '79	1879	"		
505	Ambloplilites rupestris (Raf.) Gill.	Minneapolis	"	"	June, 1879	1879	"		
506	Silurus amiurus, Pallus. (?)	"	"	C. L. Herrick	1876	1876	Geol. & N. H. Sur.		
507	Batrachus tau, Linn.	Virginia	"	Gov. Austin	1876	1876	Gov. Austin		
508	Otolitheus regalis	"	"	"	1876	1876	"		
509	Perca, sp. ?	"	"	"	1876	1876	"		
510	Prinothus, sp. ?	"	"	"	1876	1876	"		
511	Lepiopomus pallidus, (Mitch.) J. & G	Lake Minnetonka	"	T. S. Roberts	July 8, 1879	1879	T. S. Roberts		
512	Poniotis auritus, L. ?	Minneapolis	"	C. L. Herrick	Aug. 12, '77	Aug. 12, '77	Geol. & N. H. Sur.		
513		Baptism R., Minn.	"	C. W. Hall	1878	1878	"		Fish
514		Gooseberry R, L.S.	"	"	1878	1878	"		
515	Stizostithium vitreum (Mitch) J. & C	Minneapolis	"	"	May, 1880	1880	"	4	
516		Grand Marais	"	"	Apr., 1879	Aug., 1877	"	2	Fish
517		Out. Bass L, Minne	"	C. L. Herrick	June 13, '78	June 13, '78	"		Fish
518		Beav. Bay C'k, L.S	"	C. W. Hall	Aug. 29, '79	Aug. 29, '79	"	8	Fish
519	Percina manitou, Jor. ?	N. shore L. Supe.	"	"	1878	1878	"	1	
520	Salmo frontinalis, Mitch		"	C. M. Terry	Aug., 1879	1879	"	1	
521	Scaphirhynchops platyrhynchus, (Raf.) Gill	Minneapolis	"		1880	1880	"	1	Purchased
522	Cycleptus, sp. ?	"	"		1880	1880	"	1	"
523	Lepidosteus osseus, (L.) Ag.	"	"		1880	1880	"	3	"
524	Eggs of trout	St. Paul	"	R. O. Sweeny	1879	1879	State Fish Com.	Ind	Unimpregn't'd
525	Eggs of trout	"	"	"	1879	1879	"	"	Imp. 6 dy's old
526	Eggs of trout	"	"	"	1879	1879	"	"	20 days old
527	California salmon	"	"	"	1879	1879	"	"	2 weeks old
528	California salmon	"	"	"	1879	1879	"	"	3 weeks old
529	California salmon	"	"	"	1879	1879	"	2	Young frog
530	California salmon		"	"	1879	1879	"	1	Yearling
531	Lake trout		"	"	1879	1879	"	2	Young fry
532	Brook trout		"	"	1879	1879	"	1	Yearling
533	Lake trout		"	"	1879	1879	"	Ind	1 week old
534	Hyodon tergisus, Le S.	Minneapolis	"	C. W. Hall	1880	1880	Geol. & N. H. Sur.	1	Viscara exp'sd
535	Stizostethium vitreum, Mitch.	"	"	"	1880	1880	"	1	"
536	Acipenser rubicundus	"	"	"	1879	1879	"	1	Heart
537	Polyodon folium, Lac.	"	"	W. H. Holden	May, 1880	1880	W. H. Holden	1	
538	Anguilla rostrata	"	"		May 20, '80	1880	Wm. Howling	1	
539		"	"	R. O. Sweeny	1879	1879	State Fish Com.	Ind	3 weeks old

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
540	.....	Amiurus vulgaris, var. ælurus, (G'rd.) Jor.	....	Lake Minnetonka.	Alc'hol	T. S. Roberts....	July 8, 1879	July, 1879	T. S. Roberts......	1	
541	14828	Tetrodon turgidus, Mitch.	....	Noank, Con.......	"	U. S. Fish Com..		Sept., 1880	U. S. Nat. Museum		
542	16567	Alutera schoepfii, (Wall.) G. & B...	....	Wood's Holl, Mass	"	"		"	"		
543	18946	Monacanthus setifer, Bennett......	....	"	"	"		"	"		
544	23162	Gasterosteus aculeatus, L.	....	"	"	"		"	"		
545	13404	Apeltes quadracus, (Mitch) Brevoort	....	" [Glouc. M's	"	"		"	"		
546	22691	Limanda ferruginea, (Storer) G. & B	....	Minh. Id. Trap,	"	"		"	"		
547	20903	Pleuronectes glaber, (Storer) Gill...	....	Wash. Market	"	"		"	"		
548	22759	Lophopsetta maculata, (Mitch.) Gill	....	Wood's Holl, Mass	"	"		"	"		
549	24611	Hippoglossoides platessoides, (Fabr.) Gill.	....	Halifax, N. S......	"	"		"	"		
550	24619	Hippoglossoides platessoides, (Fabr.) Gill.	....	"	"	"		"	"		
551	22690	Pollachius carbonarius, (Linn.) Bon	....	Gloucester, Mass..	"	"		"	"		
552	20595	Microgadus tomcodus, (Walb.) Gill.	....	Wood's Holl, Mass	"	"		"	"		
553	22631	Phycis tenuis, (Mitch.) Dekay.......	....	Gloucester, Mass..	"	"		"	"		
554	23760	Zoarces anguillaris, (Peck.) Storer..	....	Provincetown, "	"	"		"	"		
555	18668	Dactylopterus volitans, (Linn.) Lac.	....	Wood's Holl, Mass	"	"		"	"		
556	18679	Dactylopterus volitans, (Linn.) Lac.	....	"	"	"		"	"		
557	22754	Prionotus evolans, (L.) Gill.	....	"	"	"		"	"		
558	23531	Prionotus carolinus, (L.) C. & V.....	....	Crisfield, Maryla'd	"	"		"	"		
559	24336	Aspidophoroides monophlerygius (Bloch.) Storer.	....	Provincetown, M's	"	"		"	"		
560	22266	Bottus octodecemspinosus, Mitch...	....	Gloucester, Mass..	"	"		"	"		
561	13525	Coltus æneus, Mitch.	....	Wood's Holl, Mass	"	"		"	"		
562	24340	Centridermichthys uncinatus, (Rhdt.) Gunth.	....	E. Coast, U. S.....	"	"		"	"		
563	22839	Hemitripterus americanus, (Gm.) Storer.	....	Gloucester, Mass,.	"	"		"	"		
564	22651	Sebastes marinus, Linn.	....	"	"	"		"	"		
565	13630	Tangota onitis, (Linn.) Günth	....	....	"	"		"	"		
566	17629	Tantogolabrus adspersus,(Walb)Gill	....	Noank, Mass......	"	"		"	"		

567	20340	Holconotus rhodoterus, Ag.		California	Alc'hol	U. S. Fish. Com.		Sept., 1880	U. S. Nat. Museum	
568	16224	Seccomber secombrus, Linn.		Wood's Holl	"	"		"	"	
569	18964	Decapterus punctatus, (Ag.) Gill		"	"	"		"	"	
570	22784	Trachurops crumenophthalmus, (Bloch.) Gill		"	"	"		"	"	
571	24922	Carangus hippos, (L.) Gill		"	"	"		"	"	
572	22768	Trachynotus carolinus, (L.) Gill		"	"	"		"	"	
573	10402	Seriola zonata, (Mitch.) C. & V.		"	"	"		"	"	
574	15082	Pronotus tricanthus, (Pech.) Gill		Tompkinsville, N. [Y.	"	"		"	"	
575	22757	Menticirrus nebulosus, (Mitch.) Gill		E. Coast U. S.	"	"		"	"	
576	22758	Stenotomus argyrops, (L.) Gill		Wood's Holl, Mass	"	"		"		
577	23507	Pristipoma fulvomaculatum, (Mitch) Gunth.		Norfolk, Va.	"	"		"	"	
578	24812	Micropterus pallidus, (Raf.) Gill & Jordan		North Carolina	"	"		"	"	
579	7673	Ambloplites rupestris, (Raf.) Gill		Yellow Creek, O.	"	"		"	"	
580	6246	Lepomis auritus, (L.) Gill		Sing Sing, N. Y.	"	"		"	"	
581	9266	Xenotis peltastes, (Cope.) Jordan		Michigan	"	"		"	"	
582	24877	Eupomotis aureus, (Walb.) Gill & Jor		Wash. M'kt, from	"	"		"	"	
583	24766	Centrarchus irideus, (Bosc.) C. & V.		" [N. C.	"	"		"		
584	24767	Promoxys nigromaculatus, (Le S.) Girard		Wash. Market	"	"		"	"	
585	22800	Centropristis atrarius, (L.) Barn.		Wood's Holl, Mass	"	"		"	"	
586	7441	Perca fluvialitis		Ohio	"	"		"	"	
587	24925	Morone americana, (Gmel.) Gill		Wood's Holl, Mass	"	"		"	"	
588	24846	Roccus lineatus, (Bl. Schu.) Gill		Wash. Market	"	"		"	"	
589	22762	Pomatomus saltatrix, (Linn.) Gill		Wood's Holl, Mass	"	"		"	"	
590	13095	Amodytes americanus, De Kay		"	"	"		"	"	
591	22858	Chirostoma menidium, (L.) Gill		Orland, Maine	"	"		"	"	
592	21451	Belone longirostris		Wood's Holl, Mess	"	"		"	"	
593	24896	Esox reticulatus, Le S.		Wash. Market	"	"		"	"	
594	24581	Cyprinodon variegatus, Lac.		Wood's Holl, Mass	"	"		"	"	
595	13901	Fundulus pisculentus, (Mitch.) Val.		Casco Bay, Me.	"			"	"	
596	24883	Fundulus parvipinnis		San Diego, Cal.	"			"	"	
597	8746	Percopsis guttatus, Ag.		Lake Superior	"			"	"	
598	13036	Osmerus mordax, (Mitch.) Gill		Noank, Conn.	"			"	"	
599	23184	Osmerus pacificus		Naas River, Ore.	"			"	"	
600	22405	Salmo irideus, Gibbons		California	"			"	"	
601	24434	Brevoortia tyrannus, (Latrobe) G'de		Yorktown, Va.	"			"	"	
602	20472	Alosa sapidissima, (Wils.) Linsly		S. Hadley F'ls, M's	"			"	"	
603	21687	Clupea harengus, Linn.		Ipswich Bay, Mass	"			"	"	
904	24975	Dorosoma crepidiarum, (Lac.) Gill.		Wash. Market	"			"	"	
605	24897	Erimyzon sucetta, (Lac.) Jor.		Potomac Rivar	"			"	"	
606	6853	Calostomus commersonii, (Lac.) Jor		Port Huron, Mich.	"			"	"	
607	24883	Amiurus albidus, (Le S.) Gill		Wash. Market	"			"	"	
608	23189	Amiurus catus, (L.) Gill		Potomac River	"			"	"	
609	24852	Amiurus catus, (L.) Gill		Wash. Market	"			"	"	
610	18012	Naturus insignis, (Rich.) Gill. & Jor.		Bainbridge, Penn.	"			"	"	

Zoological Accessions to the Museum——Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Obtained by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
611	13580	Anguilla rostrata, (Le S.) De Kay..	....	Wood's Holl, Mass	Alc'hol	....	....	Sept., 1880	U. S. Nat. Museum	....	....
612	22600	Squalus acanthias, L.	....	Gloucester, Mass..	"	....	....	"	"	....	....
613	.....	Larva of sphinx moth	....	Minneapolis.......	"	....	....	....	....	1	....
614	.....	Lupa, sp. ?	....	Virginia..........	"	Gov. Austin.....	1876	1876	Gov. Austin.......	2	....
615	.....	....	....	Minneapolis.......	"	....	....	....	....	1	Crayfish.......
616	.....	Lachnostirna quercina, Koch......	....	Alabama..........	"	P. H. Mell, Jr...	1888	1880	P. H. Mell, Jr.....	1	....
617	.....	Torrubra elongata, Riley..........	....	Alabama..........	"	"	1880	1880	"	....	.... [presented
618	.....	....	....	Mankato..........	"	D. Richards.....	1880	1880	D. Richards.......	1	Trap'dr spider
619	.....	....	....	Grand Marais.....	"	H. Mayhew......	1879	1879	H. Mayhew.......	1	Wat. beetle, pr
620	.....	Carambyx	....	....	"	....	....	....	....	1	Presented.....
621	.....	Corydalis	....	Minneapolis.......	"	H. Nachtrieb....	1880	1880	H. Nachtrieb......	1	" ......
622	.....	Corydalis larva..................	....	"	"	"	1880	1880	"	1	" ......
623	.....	....	....	....	"	Fred Reynolds..	1880	1880	Fred. Reynolds...	2	Im. locust, pre
624	.....	Julus, sp. ?	....	Black Hills, Da...	"	N. H. Winchell..	1874	1874	Geol. & N. H. Sur.	....	Presented.....
625	.....	Caddisfly larva	....	Grand Marais.....	"	C. W. Hall.......	1879	1879	"	....	" ......
626	.....	....	....	"	"	"	Aug., 1879	1879	"	....	Leeches, medi-
628	.....	Parasite of lake trout	....	Grand Marais.....	"	"	1879	1879	"	....	.... [cal.
529	.....	Gelasimus vocans..................	....	Virginia..........	"	Gov. Austin.....	1876	1876	Gov. Austin.......	1	Presented.....
630	.....	....	F.	Minneapolis.......	"	H. V. Winchell..	1880	1880	H. V. Winchell...	1	Crayfish with
631	.....	....	....	Minnehaha Creek	"	H. Nachtrieb....	1879	1879	H. Nachtrieb......	1	Crayfish . [eggs
632	.....	Echinus, sp. ?...................	....	Virginia..........	"	Gov. Austin.....	1876	1876	Gov. Austin.......	1	Presented.....
633	-....	Ophiura, sp. ?...................	....	"	"	"	1876	1876	"	1	" .....
634	.....	Asterias, sp. ?...................	....	"	"	"	1876	1876	"	1	" .....
635	.....	Lupa, sp. ?......................	....	"	"	"	1876	1876	"	1	" .....
636	.....	Nepa apiculata ?, etc.,..........	....	Black Hills, Da...	"	N. H. Winchell..	1874	1874	Geol. & N. H. Sur.	1	Custer Exp....
637	.....	....	....	Minneapolis.......	"	H. Nachtrieb....	1879	1879	H. Nachtrieb......	1	Crayfish.......
638	.....	....	....	....	"	....	....	....	....	2	" ....
639	1	Nymphon hirtum, Fabr..............	....	Off Halifax, N. S.	"	U. S. Fish Com..	1877	May, 1880	U. S. Fish. Com...	1	....
640	2 a	Limulus polyphemus, Latr...........	....	Cape Cd Bay, shore	Dry....	"	1879	"	"	1	....
641	2 c	Gelasimus pugnax, Smith...........	....	New Haven, Conn	In Alch	"	....	"	"	1	....
642	3 a	Callinectes hastatus, Ordway.......	....	" [shore.	"	"	....	"	"	1	....
643	3 b	Platyonichus ocellatus, Latr........	....	Cape C'd B, surface	"	"	....	"	"	6	Young.........
644	4	Platyonichus ocellatus, Latr........	....	Vineyard S'd, M'ss	Dry....	"	....	"	"	1	....

645	5	Cancer irroratus, Say	Vineyard S'd, M'ss	In Alch	U. S. Fish Com.		May, 1880	U. S. Fish Com.	1	
646	5 a	Cancer irroratus, Say	Glouc. Mass. shore	"	"		"	"	4	Young
647	6	Hyas coarctatus, Leach	Gulf of Maine, 22 to 30 fath	"	"		"	"	1	
648	7	Libinia emarginata, Leach	Vineyard S'd, M'ss	"	"		"	"	1	
649	9	Eupagurus pollicaris, Stimp	Off Nantucket I.	"	"		"	"	2	
450	9 a	Eupagurus pollicaris, Stimp	Off Noauk, Conn.	"	"		"	"	1	
651	10	Eupagurus pubescens, Brandt	Coast of Maine, 22 to 34 fath	"	"		"	"	1	
652	11	Eupagurus bernhardus, Brandt	Gloucester, Mass.	"	"		"	"	1	
653	11 a	Homarus americanus, Edw	New Haven, Conn	"	"		"	"	2	
654	12	Crangon vulgaris, Fab	Mass. Coast	"	"		"	"	4	
655	13	Pandalus borealis, Kroyer	Mass. B., 41 to 50 fa	"	"		"	"	Ind	
656	14	Pandalus montagui, Leach	" 42 to 50 fa	"	"		"	"	"	
657	15	Hyppolyte spina, Leach	Bay of Fundy, 10 to 20 fath	"	"		"	"	"	
658	15 a	Thysanopoda inermis, Kroyer	Cape Cod	"	"		"	"	"	From whale's [stomach
659	16	Thysanopoda norvegica, M. Sars	B. of Fundy, surf'c	"	"		"	"	3	
660	17	Mysis mixta, Lillyeborg	Mass. B., 40 to 50 fa	"	"		"	"	2	
661	18	Diastylis quadrispinosus, G. O. Sars	Off Grand Menan I., 8 to 10 fath	"	"		"	"	2	
662	19	Ptilocheirus pinguis, Stimp	Lang I. Sound, off Noank, Conn.	"	"		"	"	5	
663	19 a	Talorchestia longicornis, Smith	Cape Cod, shore	"	"	1879	"	"	1	
664	20	Gammarus locusta, Fab	Gloucester H'rb, Ct	"	"		"	"	2	
665	21	Idotea robusta, Kroyer	Vineyard S'd, M'ss	"	"		"	"	2	
666	22	Idotea irrorata, Edw	"	"	"		"	"	3	
667	22 a	Æga psora, Kroyer	George's Banks	"	"		"	"	1	(On codfish)
668	23	Lepas facicularis, Ellis & Sol	Vineyard S'd, M'ss	"	"		"	"	Ind	
669	23 a	Balanus balanoides, Stimp	New Haven, Conn shore	"	"		"	"	"	
670	24	Lepidonotus squamatus, Deach	Bay of Funday, 10 to 25 fath	"	"		"	"	4	
671	25	Harmothoe imbricata, Mal..g	Bay of Funday, 10 to 25 fath	"	"		"	"	2	
672	27	Nephthys incisa, Malmgren	Off Vineyard S'd, 10 to 20 fath	"	"		"	"	3	
673	28	Nereis pelagica, Linn	Vineyard Sound, 6 to 12 fath	"	"		"	"	4	
674	29	Nereis virens, Malmgren	Gloucester, Mass. shore	"	"		"	"	Ind	
675	30	Nothria conchylega, Malmgren	Gulf of Me., 85 fath	"	"		"	"	3	
676	31	Nothria opalina, Verril	Gulf of Me., 97 to 175 fath	"	"		"	"	1	
677	32	Arebella opalina, Verril	Vineyard Sound, 8 to 12 fath	"	"		"	"	2	
678	34	Sternaspis fossor, Stimp	Mass. B, 25 to 45 fa.	"	"		"	"	7	
679	35	Clymnella torquata, Verril	Glouc., Mas., shore	"	"		"	"	4	

Zoological Accessions to the Museum——Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Obtained by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
611	13589	Anguilla rostrata, (Le S.) De Kay..	....	Wood's Holl, Mass	Alc'hol	....	....	Sept., 1880	U. S. Nat. Museum	....	....
612	22660	Squalus acanthias, L..............	....	Gloucester, Mass..	"	....	....	"	"	....	....
613	.....	Larva of sphinx moth..............	....	Minneapolis.......	"	....	....	....	....	1	....
614	.....	Lupa, sp. ?..........................	....	Virginia..........	"	Gov. Austin.....	1876	1876	Gov. Austin.......	2	....
615	.....	....	....	Minneapolis.......	"	....	....	....	....	1	Crayfish.......
616	.....	Lachnostirna quercina, Koch........	....	Alabama..........	"	P. H. Mell, Jr...	1888	1880	P. H. Mell, Jr.....	1	....
617	.....	Torrubra elongata, Riley............	....	Alabama..........	"	"	1880	1880	"	....	....[presented
618	.....	....	....	Mankato..........	"	D. Richards.....	1880	1880	D. Richards.......	1	Trap'dr spider
619	.....	....	....	Grand Marais.....	"	H. Mayhew......	1879	1879	H. Mayhew.......	1	Wat. beetle, pr
620	.....	Carambyx..............................	....	....	"	....	....	....	....	1	Presented.....
621	.....	Corydalis..............................	....	Minneapolis.......	"	H. Nachtrieb....	1880	1880	H. Nachtrieb......	1	" .....
622	.....	Corydalis larva........................	....	"	"	"	1880	1880	"	1	" .....
623	.....	....	....	....	"	Fred Reynolds..	1880	1880	Fred. Reynolds...	2	Im. locust, pre
624	.....	Julus, sp. ?...........................	....	Black Hills, Da...	"	N. H. Winchell..	1874	1874	Geol. & N. H. Sur.	....	Presented.....
625	.....	Caddisfly larva........................	....	Grand Marais.....	"	C. W. Hall.......	1879	1879	"	....	" .....
626	.....	....	....	"	"	"	Aug., 1879	1879	"	....	Leeches, medi-
628	.....	Parasite of lake trout................	....	Grand Marais.....	"	"	1879	1879	"	....	..........[cal.
629	.....	Gelasimus vocans.....................	....	Virginia..........	"	Gov. Austin.....	1876	1876	Gov. Austin.......	1	Presented.....
630	.....	....	F.	Minneapolis.......	"	H. V. Winchell..	1880	1880	H. V. Winchell...	1	Crayfish with
631	.....	....	....	Minnehaha Creek	"	H. Nachtrieb....	1879	1879	H. Nachtrieb......	1	Crayfish .[eggs
632	.....	Echinus, sp. ?........................	....	Virginia..........	"	Gov. Austin.....	1876	1876	Gov. Austin.......	1	Presented.....
633	.....	Ophiura, sp. ?.........................	....	"	"	"	1876	1876	"	1	" .....
634	.....	Asterias, sp. ?........................	....	"	"	"	1876	1876	"	1	" .....
635	.....	Lupa, sp. ?............................	....	"	"	"	1876	1876	"	1	" .....
636	.....	Nepa apiculata ?, etc.,...............	....	Black Hills, Da...	"	N. H. Winchell..	1874	1874	Geol. & N. H. Sur.	1	Custer Exp....
637	.....	....	....	Minneapolis.......	"	H. Nachtrieb....	1879	1879	H. Nachtrieb......	1	Crayfish.......
638	.....	....	....	....	"	....	....	....	....	2	" ....
639	1	Nymphon hirtum, Fabr...............	....	Off Halifax, N. S.	"	U. S. Fish Com..	1877	May, 1880	U. S. Fish. Com...	1	....
640	2 a	Limulus polyphemus, Latr...........	....	Cape Cd Bay, shore	Dry....	"	1879	"	"	1	....
641	2 c	Gelasimus pugnax, Smith............	....	New Haven, Conn	In Alch	"	....	"	"	1	....
642	3 a	Callinectes hastatus, Ordway.......	....	" [shore.	"	"	....	"	"	1	....
643	3 b	Platyonichus ocellatus, Latr........	....	Cape C'd B, surface	"	"	....	"	"	6	Young.........
644	4	Platyonichus ocellatus, Latr........	....	Vineyard S'd, M'ss	Dry....	"	....	"	"	1	....

645	5	Cancer irroratus, Say	....	Vineyard S'd, M'ss	In Alch	U. S. Fish Com.	....	May, 1880	U. S. Fish Com.	1	....
646	5 a	Cancer irroratus, Say	....	Glouc. Mass, shore	"	"	....	"	"	4	Young
647	6	Hyas coarctatus, Leach	....	Gulf of Maine, 22 to 30 fath	"	"	....	"	"	1	....
648	7	Libinia emarginata, Leach	....	Vineyard S'd, M'ss	"	"	....	"	"	1	....
649	9	Eupagurus pollicaris, Stimp	....	Off Nautucket I.	"	"	....	"	"	2	....
450	9 a	Eupagurus pollicaris, Stimp	....	Off Noauk, Conn.	"	"	....	"	"	1	....
651	10	Eupagurus pubescens, Brandt	....	Coast of Maine, 22 to 34 fath	"	"	....	"	"	1	....
652	11	Eupagurus bernhardus, Brandt	....	Gloucester, Mass.	"	"	....	"	"	1	....
653	11 a	Homarus americanus, Edw	....	New Haven, Conn	"	"	....	"	"	2	....
654	12	Crangon vulgaris, Fab	....	Mass. Coast	"	"	....	"	"	4	....
655	13	Pandalus borealis, Kroyer	....	Mass. B., 41 to 50 fa	"	"	....	"	"	Ind	....
656	14	Pandalus montagui, Leach	....	" 42 to 50 fa	"	"	....	"	"	"	....
657	15	Hyppolyte spina, Leach	....	Bay of Fundy, 10 to 20 fath	"	"	....	"	"	"	....
658	15 a	Thysanopoda inermis, Kroyer	....	Cape Cod	"	"	....	"	"	"	From whale's [stomach
659	16	Thysanopoda norvegica, M. Sars	....	B. of Fundy, surf'c	"	"	....	"	"	3	....
660	17	Mysis mixta, Lillyeborg	....	Mass. B., 40 to 50 fa	"	"	....	"	"	2	....
661	18	Diastylis quadrispinosus, G. O. Sars	....	Off Grand Menan I., 8 to 10 fath	"	"	....	"	"	2	....
662	19	Ptilocheirus pinguis, Stimp	....	Lang I. Sound, off Noank, Conn.	"	"	....	"	"	5	....
663	19 a	Talorchestia longicornis, Smith	....	Cape Cod, shore	"	"	1879	"	"	1	....
664	20	Gammarus locusta, Fab	....	Gloucester H'rb, Ct	"	"	....	"	"	2	....
665	21	Idotea robusta, Kroyer	....	Vineyard S'd, M'ss	"	"	....	"	"	2	....
666	22	Idotea irrorata, Edw	....	"	"	"	....	"	"	3	....
667	22 a	Æga psora, Kroyer	....	George's Banks	"	"	....	"	"	1	(On codfish)
668	23	Lepas facicularis, Ellis & Sol	....	Vineyard S'd, M'ss	"	"	....	"	"	Ind	....
669	23 a	Balanus balanoides, Stimp	....	New Haven, Conn shore	"	"	....	"	"	"	....
670	24	Lepidonotus squamatus, Deach	....	Bay of Funday, 10 to 25 fath	"	"	....	"	"	4	....
671	25	Harmothoe imbricata, Mal..g	....	Bay of Funday, 10 to 25 fath	"	"	....	"	"	2	....
672	27	Nephthys incisa, Malmgren	....	Off Vineyard S'd, 10 to 20 fath	"	"	....	"	"	3	....
673	28	Nereis pelagica, Linn	....	Vineyard Sound, 6 to 12 fath	"	"	....	"	"	4	....
674	29	Nereis virens, Malmgren	....	Gloucester, Mass. shore	"	"	....	"	"	Ind	....
675	30	Nothria conchylega, Malmgren	....	Gulf of Me., 85 fath	"	"	....	"	"	3	....
676	31	Nothria opalina, Verril	....	Gulf of Me., 97 to 175 fath	"	"	....	"	"	1	....
677	32	Arebella opalina, Verril	....	Vineyard Sound, 8 to 12 fath	"	"	....	"	"	2	....
678	34	Sternaspis fossor, Stimp	....	Mass. B, 25 to 45 fa.	"	"	....	"	"	7	....
679	35	Clymnella torquata, Verril	....	Glouc., Mas., shore	"	"	....	"	"	4	....

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number	NAME.	Sex	Locality.	Nature of Specimens.	Collected by	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
680	36	Thelepus cincinnatus, Malmgren		Bay of Fundy, 10 to 30 fath	Alc'hol	U. S. Fish Com		May, 1880	U. S. F. C	3	
681	37 a	Spirorbis lucidus, Mörch		Halifax, N. S	"	"		"	"	Ind	
682	38	Spirorbis borealis, Dund		Glouc., Mss., shore	"	"		"	"	"	
683	39	Clitellio irrorata, Verril		"	"	"		"	"	"	
684	41	Sagitta elegans, Verril		Viney'dS's,surface	"	"		"	"	"	
685	43	Cerebrantulus ingeus, Verril		Glouc., M'ss, shore	"	"		"	"	2	
686	44	Cerebrantulus roseus, Verril		"	"	"		"	"	3	
687	45	Pentacta frondosa, Jaeg		Bay of Fundy, 10 to 40 fath	"	"		"	"	2	
688	45 a	Lophothuria fabricii, Verril		Grand Menan, N. B	"	"		"	"	1	
689	46	Thyone briareus, Selenlea		Vineyard S'd, M'ss	"	"		"	"	2	
690	47	Echinara chincusparma, Gray		"	Dry	"		"	"	4	
691	49	Strongylocentrotus dröbachiensis, A. Ag		Wood's Holl, Mass	Alc'hol	"		"	"	1	
692	49 a	Strongylocentrotus dröbachiensis, A. Ag		Off Cape Cod, 20 to 40 fath	"	"	1879	"	"	2	
693	50 a	Arbacia punctulata, Gray		Wood's Holl, Mass	Dry	"		"	"	1	
694	51	Asterias vulgaris, Stimp		Halifax, N. S	Alc'hol	"		"	"	1	
695	52	Asterias forbesii, Verril		Vineyard S'd, M'ss	"	"		"	"	1	
696	53	Asterias forbesii, Verril		"	Dry	"		"	"	2	
697	53 a	Asterias frobesii, Verril		"	Alc'hol	"		"	"	10	
698	54	Leplasterias compta, Verril		Off Watch Hill, R. I., 22 fath	"	"		"	"	1	
699	55	Cribrella sanguinolenta, Lutken		Mass. Bay, Gulf of Maine	"	"		"	"	2	
700	56	Ctenodiscus crispatus, D. & Kor		Mass. B, 40 to 50 fa	"	"		"	"	9	
701	56 a	Ctenodiscus crispatus, D. & Kor		" "	Dry	"		"	"	6	
702	57	Ophiopholis aculeata, Gray		Bay of Fundy, 10 to 100 fath	Alc'hol	"		"	"	1	
703	58	Ophiopholis aculeata, Gray		Mass. Bay and Gulf of Maine	"	"		"	"	Ind	

704	59	Ophioglypha sarsii, Lyman	....	Mass. Bay, 20 to 125 fath..........	Alc'hol	U. S. Fish Com..	....	May, 1880..	U. S. F. C......	5	....
705	59 a	Ophioglypha sarsii, Lyman.........	....	Mass. Bay, 20 to 125 fath..........	Dry...	"	....	" ..	"	3	....
706	60	Ophioglypha robusta, Lyman......	....	Bay of Fundy.....	Alc'hol	"	....	" ..	"	2	....
707	60 c	Astrophyton agassizii Stemp.......	....	Off Cape Cod, 25 to 35 fath..........	"	"	1879	" ..	"	...	....
708	61 a	Urticina nodosa, Verril.............	....	Off Nova Scotia...	"	"	....	" ..	"	1	....
709	64	Alcyonium carneum, Ag............	....	Casco B.,20 to 60 fa	"	"	....	" ..	"	1	....
710	65	Obelia geniculata, Hincks...........	....	Vineyard S'd, M'ss	"	"	....	" ..	"	Ind	....
711	66	Obelia dichotoma, Hincks	....	Casco Bay, Maine.	"	"	....	" ..	"	"	....
712	68	Sertularia cupressina, Linn..........	....	Nantucket Shoals	"	"	....	" ..	"	"	....
713	70	Sertularia pumila, Linn..............	....	Gloucester, Mass., low water.......	"	"	....	" ..	"	"	....
714	71	Hydrallmania falcata, Hincks.......	....	B. of Fdy,10 to 60 fa	"	"	....	" ..	"	"	....
715	72	Sertularella tricuspidata, Hincks...	....	" 50 to 55 fa	"	"	....	" ..	"	"	....
716	73	Diphasia fallax, Aggasiz.............	....	" 20 to 55 fa	"	"	....	" ..	"	"	....
717	73 a	Diphasia fallax, Aggasiz.............	....	Vineyard S'd, M'ss	"	"	....	" ..	"	"	....
718	76	Loligo pealii, Le Sueur...............	....	"	"	"	....	" ..	"	2	....
719	79	Buccinium undatum, Linn...........	....	Bay of Fundy.....	Dry...	"	....	" ..	"	1	....
720	80	Tritia trivittata, H. & A. Ad..	....	Vineyard S'd, M'ss	" ...	"	....	" ..	"	...	....
721	81	Ilyanassa obsoleta, Stimp............	....	"	" ...	"	....	" ..	"	...	....
722	81 a	Ilyanassa obsoleta, Stimp............	....	Gloucester, Mass..	Alc'hol	"	....	" ..	"	10	....
723	82	Urosalpinx cinerea, Stimp............	....	Vineyard S'd, M'ss	Dry....	" ...	....	" ..	"	...	....
724	83	Purpura lapillus, Lamarck	....	Gloucester, Mass.	Alc'hol	"	....	" ..	"	6	....
725	83 a	Purpura lapillus, Lamarck............	....	Casco Bay, Me....	Dry....	"	....	" ..	"	4	....
726	84	Anachis avara, Perkins...............	....	Vineyard S'd,Mass	" ...	"	....	" ..	"	4	....
727	85	Astyris lunata, Dall....................	....	"	" ...	"	....	" ..	"	...	....
728	86	Lunatia heros, H. & A. Ad..........	....	"	" ...	"	....	" ..	"	1	....
729	87	Lunatia heros, H. & A. Ad...........	....	Gloucester, Mass..	Alc'hol	"	....	" ..	"	2	....
730	88	Littorina littorea, Menke............	....	"	"	"	....	" ..	"	4	....
731	88 a	Littorina palliata, Gould..............	....	Casco Bay, Me....	Dry	"	....	" ..	"	3	....
732	89	Littorina palliata, Gould..............	....	Gloucester, Mass..	Alc'hol	"	....	" ..	"	10	....
733	89 a	Littorina rudis, Gould.................	....	Casco Bay, Me.....	"	"	....	" ..	"	Ind	....
734	90	Lacuna vincta, Turton.................	....	Gloucester, Mass..	"	"	....	" ..	"	8	....
735	91	Bittium nigrum, Stimpson............	....	Vineyard S'd,Mass	Dry.. ..	"	....	" ..	"	...	....
736	92	Crepidula fornicata Lam..............	....	"	" ...	"	....	" ..	"	...	....
737	95	Margarita helicina, Möll..............	....	Grand Menan.....	" ...	"	....	" ..	"	4	....
738	96	Acmæa testudinalis, Han.............	....	Casco Bay, Me....	Alc'hol	"	....	" ..	"	6	....
739	96 a	Trachydermon ruber, Carp...........	....	Eastport, Maine..	"	"	....	" ..	"	2	....
740	97	Melampus lineatus, Say...............	....	Barnstable, Mass.	Dry.. ..	"	....	" ..	"	...	....
741	98	Entalis striolata, Stimpson............	....	Eastport, Me......	" ...	"	....	" ..	"	2	....
742	99	Clidophora trilineata, Carp...........	....	Vineyard S'd, M'ss	" ...	"	....	" ..	"	...	....
743	100	Spisula solidissima, Gray	....	"	" ...	"	....	" ..	"	3	....
744	100 a	Spisula solidissima, Gray	....	"	" ...	"	....	" ..	"	2	Young.........
745	102	Macoma subulosa, Mörch............	....	Mass Bay and Gulf of Me............	" ...	"	....	" ..	"	2	....
746	103	Venus mercenaria, Linn..............	....	New Haven, Ct...	" ...	"	....	" ..	"	2	....

Zoological Accessions to the Museum—Continued.

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747	104	Cyprina islandica, Lam	....	Mass Bay and Gulf of Maine	Dry	U. S. Fish Com.	....	May, 1880	U. S. F. C.	2	....
748	105	Astarte undata, Gould	....	Eastport, Maine	"	"	....	"	"	2	....
749	106	Toldia limatula, Wooda.	....	Vineyard S'd, M'ss	"	"	....	"	"	....	....
750	107	Toldia thraciformis, Stimp	....	Mass Bay and Gulf of Maine	"	"	....	"	"	2	....
751	108	Scapharca transversa, Ad.	....	Vineyard S'd, M'ss	"	"	....	"	"	4	....
952	108 a	Modiola phicatula, Lamk	....	New Haven, Ct., Shore	Alc'hol	"	....	"	"	4	....
753	109	Modiola modiolus, Turton	....	Vineyard S'd, M'ss	Dry	"	....	"	"	1	....
754	109 b	Mytilus edulis, Linn	....	New Haven, Ct., shore	Alc'hol	"	....	"	"	4	....
755	110	Pecten irradius, Lamk	....	Vineyard S'd, M'ss	Dry	"	....	"	"	4	....
756	111	Pecten tennicostatus, Migh	....	Off Watch Hill, R. I., 22 fath	"	"	....	"	"	1	....
757	112	Anomia aculeata, Gmelin	....	Casco Bay, Me.	"	"	....	"	"	....	....
758	112 a	Ostrea virginiana, Lister	....	New Haven, Ct.	"	"	....	"	"	1	....
759	113	Venericardia borealis, Carp	....	Off Noank, Conn.	"	"	....	"	"	4	....
760	114	Nucula proxima, Say	....	Buzzard's B. and Vineyard S'd	"	"	....	"	"	....	....
761	115	Mya arenaria, Linn	....	Gilford, Conn.	Alc'hol	"	....	"	"	1	....
762	120	Ascidia mollis, Verril	....	Gulf of Maine, 50 to 175 fath	"	"	....	"	"	1	....
763	121	Ascidiopsis complanata, Verril	....	B. of Fundy, shore to 50 fath	"	"	....	"	"	2	....
764	122	Molgula retoriformis, Verril	....	Bay of Fundy, 10 to 25 fath	"	"	....	"	"	2	....
765	123 b	Molgula manhattensis, Verril	....	Cape Cod, shore	"	"	1879	"	"	Ind	....
766	124	Glandula arenicola, Verril	....	Vineyard S'd, 10 to 20 fath	"	"	....	"	"	Ind	....
767	125	Halocynthia partita, Verril	....	Vineyard S'd, 3 to 12 fath	"	"	....	"	"	Ind	....

768	126	Halocynthia echinata, Verril	....	Grand Manan, 1 to 40 fath	Alc'hol	U. S. Fish Com.	....	May, 1880	U. S. Fish Com.	3	....
769	127	Halocynthia pyriformis, Verril	....	Bay of Fundy, 1 to 45 fath	"	"	....	"	"	2	....
770	128	Boltenia bolteni, Linn	....	Eastport, Me., 1 to 20 fath	"	"	....	"	"	Ind	....
771	129	Perophora veridis, Verril	....	Vineyard S'd, 1 to 12 fath	"	"	....	"	"	Ind	....
772	130	Botryllus gouldii, Verril	....	Viney'd S'd, shore	"	"	....	"	"	1	....
773	131	Amoræcium pellucidum, Verril	....	"	"	"	....	"	"	4	....
774	132	Amoræcium stellatum, Verril	....	"	"	"	....	"	"	2	....
775	133	Amoræcium constellatum, Verril	....	Off Nantucket, Mss	"	"	....	"	"	2	....
776	134	Leptochinum albidum, Verril	....	Vineyard S'd, M'ss	"	"	....	"	"	1	....
777	135	Leptochinum albidum, var. luteolum, Verril	....	"	"	"	....	"	"	Ind	....
778	136	Salpa caboti, Desor	....	" shore	"	"	....	"	"	6	....
779	137	Terebratulina septemtrionalis, Gr.	....	Casco Bay, Me.	"	"	....	"	"	4	....
780	137 a	Terebratulina septemtrionalis, Gr.	....	Eastport, Me., 1 to 60 fath	"	"	....	"	"	5	....
781	138	Crisia eburnea, Lamouroux	....	Gloucester, Mass.	"	"	....	"	"	Ind	....
782	142	Flustrella hispida, Gray	....	" shore	"	"	....	"	"	"	....
783	143 a	Gemellaria loricata, Bush	....	Off Cape Cod, 20 to 40 fath	"	"	1879	"	"	"	....
784	146	Bugula murrayana, Bush	....	Nantucket shoals, 8 to 12 fath	"	"	....	"	"	"	....
785	147	Bugula turrita, Verril	....	Vineyard S'd and off Nantucket	"	....	....	"	"	"	....
786	148	Mucronella nitida, Verril	....	Vineyard S'd, M'ss	Dry	"	....	"	"	"	....
787	149	Membranopora pilosa, Farre	....	Gloucester, Mass.	Alc'hol	"	....	"	"	"	....
788	149 a	Membranopora pilosa, Farre	....	"	"	"	....	"	"	"	....
789	151	Hippothoa hyalina, Smith	....	Vineyard S'd, M'ss	Dry	"	....	"	"	....	....
790	154 a	Chalina oculata, Bowerb.	....	Casco Bay, Me.	"	"	....	"	"	2	....
791	155	Luberites compacta, Verril	....	Off Nantucket, M's	"	"	....	"	"	2	....
792	156 a	Luberites compacta, Verril	....	Cape Cod B., 15 fa	Alc'hol	"	....	"	"	1	....
793	156aa	Luberites compacta, Verril	....	....	Dry	"	....	"	"	2	....
794	157	Cliona sulphurea, Verril	....	Vineyard S'd, M'ss	"	"	....	"	"	1	....
795	....	Skull of Gen. Custer's hound	M.	Minneapolis	Mt'd	E. S. Williams	1880	1880	E. S. Williams	1	....
796	....	Skull of lynx	....	Grand Marais	"	C. W. Hall	"	"	Mayhew Bros.	1	....
797	....	Skull of lynx	....	"	"	"	"	"	"	1	....
798	....	Skull of ——	....	"	"	"	"	"	"	2	....
799	....	Skull of fisher (?)	....	"	"	"	"	"	"	1	....
800	....	Skull of rat	....	"	"	"	"	"	"	1	....
801	....	Skull of bear	....	"	"	"	"	"	"	1	..[by purchase
802	....	....	M.	England	"	....	....	"	Wakelin	1	Gold. pheasant
803	....	....	M.	"	"	....	....	"	"	1	Starling
804	....	....	F.	"	"	....	....	"	"	1	Europ'an quail
805	....	Pinecola canadensis	F.	"	"	....	....	"	"	1	Pure grosbeak
806	....	....	....	"	"	....	....	"	"	1	Sky lark

Zoological Accessions to the Museum—Continued.

Catalogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimen.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
807	....				Mt'd.		1880	1880	Wakelin	1	Honey eater
808	....	Florida cerulea	M.		"	E. Moulton	1880	1880	Wm. Howling	1	Purchased
809	....	Mareca americana	F.		"		1876	1880	"	1	"
810	....	Mereca americana	M.		"		1876	1880	"	1	"
811	....	Anas boschas	M.	Minneapolis	"		1877	1880	"	1	"
812	....	Anas boschas	F.	Sandy L. M'polis	"	Wm. Howling	June, 1880	1880	"	1	"
813	....	Bucephala albeola	M.	"	"		1879	1880	"	1	"
814	....	Bucephala albeola	F.	Minnehaha	"		June, 1880	1880	"	1	"
815	....	Erismatura rubula	F.	Mississippi R.	"		1877	1880	"	1	"
816	....	Erismatura rubula	M.	"	"		1877	1880	"	1	"
817	....	Lophodytes cucullatus	M.	Minneapolis	"		May, 1880	1880	"	1	"
818	....	Lophodytes cucullatus	F.	"	"		June, 1879	1880	"	1	"
819	....	Dafila acuta	M.	Minnetonka	"		June, 1880	1880	"	1	"
820	....	Dafila acuta	F.	"	"			1880	"	1	"
821	....	Aix sponsa	M.	Minneapolis	"			1880	Wakelin	2	Eng. partridge
822	....			England	"		June, 1879	1880	C. L. Herrick		Purchased
823	....	Chrysomitris tristis, (L.) Bon	M.	Minneapolis	"	C. L. Herrick	1879	1880	"		"
824	....	Euspiza americana, (Gm.) Bon	M.	"	"	"	1879	1880	"		"
825	....	Icterus baltimore	M.	"	"	"	1879	1880	"		"
826	....	Molothrus ater (Bodd.) Gray	M.	"	"	"	1879	1880	"		"
827	....	Dolichonyx oryzivorus, (L.) Sw	M.	"	"	"	1878	1880	"		"
828	....	Sialia sialis, L.	M.	"	"	"	1879	1880	"		"
829	....	Contopus borealis, (Sw.) Bd		"	"	"	1879	1880	"		"
830	....	Mimus carolinensis, L.	M.	"	"	"	1379	1880	"		"
831	....	Melospiza melodia, Bd		"	"	"	1879	1880	"		"
832	....	Goniaphea ludoviciana, Bond	M.	"	"	"	1879	1880	"		"
833	....	Goniaphea ludoviciana, Bond	F.	"	"	"	1879	1880	"		"
834	....	Quiscalus purpureus,(Barber) Licht.	M.	"	"	"	1879	1880	"		"
835	....	Agelæus, ?		"	"	"	1876	1880	"		"
836	....	Turdus migratorius, L.		"	"	"	1879	1880	"		"
837	....	Callinectus hastatus		Salem, Mass.	Alc'hol	C. W. Hall	Aug., 1880	1880	C. W. Hall	3	
838	....	Sarda pelamys		Manchester, Mass.	"	"	"	1880	"		
839	....	Tautogolabrus adspersus, Gill		"	"	"	"	1880	"	Sev	

840	.....	Asterias vulgaris	....	Salem, Mass.	Alc'hol	C. W. Hall	Aug. 1880	1880	C. W. Hall	Ind	....
841	.....	Loligo pealii, Le S.	....	Manchester, Mass.	"	"	"	1880	"	12	....
842	.....	Homarus americanus, Dekay	....	Salem, Mass.	"	"	"	1880	"	2	....
843	.....	Bucephala islandica	F.	Minneapolis	M'td	C. L. Herrick	Jan. 1877	1877	C. L. Herrick	....	Presented
844	.....	Ampelis cedrorum, L.	M.	Owatonna	"	M. B. Dunnell	Mar. 28, '81	1881	M. B. Dunnell	....	"
845	.....	Ampelis cedrorum, L.	F.	Owatonna	"	"	"	1881	"	....	"
846	.....	Scomber scombrus, L.	....	Manchester, Mass.	Alc'hol	C. W. Hall	Aug. 1880	1880	C. W. Hall	3	....
848	.....	Merlucius bilinearis, Gill	....	Salem, Mass.	"	"	"	1880	"	1	....
848	.....	Clupea harengus, L.	....	Manchester, Mass.	"	"	"	1880	"	Sev	....
849	.....	Pomolobus pseudoharengus, Gill	....	"	"	"	"	1880	"	4	....
850	.....	Rana pipens, L.	....	Salem, Mass.	"	"	"	1880	"	6	....
851	27284	Gasterosteus (aculeatus, var.) cataphractus, (Pallas) J. & G.	....	Puget Sound	"	U. S. Fish Com.	....	1881	U. S. Nat. Museum	1	....
852	27115	Pleuronichthys decurrens, J. & G.	....	San Francisco, Cal	"	"	....	1881	"	1	Type
853	27273	Pleuronectes stellatus, Pallas	....	Puget Sound	"	"	....	1881	"	1	....
854	27121	Parophrys isolepis, (Lock.) J. & G.	....	"	"	"	....	1281	"	1	Type
855	27057	Parophrys vetulus, Grd.	....	Monterey, Cal.	"	"	....	1881	"	1	"
856	27325	Citarichthys sordidus, (Grd.) Gthr.	....	Puget Sound	"	"	....	1881	"	1	....
857	27121	Hippoglossoides exilis, J. & G.	....	San Francisco, Cal	"	"	....	1881	"	1	Type
858	27263	Hidpoglossoides elassodon, J. & G.	....	Puget Sound	"	"	....	1881	"	1	"
859	24874	Paralichthys maculosus, Grd.	....	San Diego, Cal.	"	"	....	1881	"	1	"
860	27258	Lumpenus anguillaris, (Pallas) Gill	....	Puget Sound	"	"	....	1881	"	1	....
861	27327	Xiphister rupestris, Jor. & Gill	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	Type
862	27001	Xiphister rupestris, Jor. & Gill	....	Monterey, Cal.	"	"	....	1881	"	1	"
863	26999	Xiphister mucosus, (Grd.) Jor.	....	"	"	"	....	1881	"	1	....
864	27328	Xiphister mucosus, (Grd.) Jo.r	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	....
865	26998	Cebedichthys violaceus, Grd.	....	Monterey, Cal.	"	"	....	1881	"	1	....
866	27339	Anopharchus alectrolophus, (Pallas) J. & G.	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	....
867	26994	Apodichthys fucorum, Jor. Gill	....	Monterey, Cal.	"	"	....	1881	"	1	Type
868	27330	Murænoides ornatus, (Grd.) Gill	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	....
869	27277	Porichthys porosissimus, (Cuv. & Val.) Gthr.	....	Puget Sound	"	"	....	1881	"	1	....
870	27329	Gobiesox reticulatus, Grd.	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	....
871	27331	Ascelichthys rhodorus, J. & G.	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	Type
872	27133	Artedius quadriseriatus, Lock.	....	San Francisco Cal	"	"	....	1881	"	1	....
873	27261	Aspicottus bison, Grd.	....	Puget Sound	"	"	....	1881	"	1	....
874	27267	Leptocottus armatus, Grd.	....	"	"	"	....	1881	"	1	....
875	27333	Oligocottus maculosus, Grd.	....	Cape Flattery, Wash. Territory	"	"	....	1881	"	1	....
876	27051	Oligocottus analis. Grd.	....	Monterey, Cal.	"	"	....	1881	"	1	....
877	25076	Sebastichthys chrysomelas, J. & Gilb	....	Santa Barbara Cal	"	"	....	1881	"	1	Type
878	26908	Sebastichthys rastrelliger, J. & Gilb	....	Santa Barbara Cal	"	"	....	1881	"	1	"

Zoological Accessions to the Museum—Continued.

Catelogue No.	Original Number.	NAME.	Sex	Locality.	Nature of Specimens.	Collected by.	When Collected.	OBTAINED. When.	OBTAINED. Whence.	No. of Specimens.	Remarks.
879	27293	Sebastichthys auriculatus, (Grd.) Gill (var.)	....	Puget Sound	Alc'hol	U. S. Fish Com.	....	1881	U. S. Nat. Museum	1	....
880	26961	Sebastichthys rosaceus, (Grd.) Lich.	....	Monterey, Cal	"	"	....	1881	"	1	....
881	27278	Hexagramus dicagramus, (Pallas) J & G	M.	Puget Sound	"	"	....	1881	"	1	....
882	27027	Zanolipis latipinnis, Grd	....	Point Reges, near San Francisco	"	"	....	1881	"	1	....
883	27282	Anoplopoma fimbria, (Pallas) Gill.	....	Puget Sound	"	"	....	1881	"	1	....
884	26794	Gillichthys mirabilis, Cooper	....	San Diego, Cal	"	"	....	1881	"	1	....
885	27376	Pseudojulis modestus,(Grd.) Gthr.	....	Santa Barbara Cal	"	"	....	1881	"	1	....
886	27078	Abeona minima, (Gibbons) Gill	....	Monterey, Cal	"	"	....	1881	"	1	....
887	26996	Abeona aurora, Jor. & Gilb	....	"	"	"	....	1881	"	1	Type
888	27296	Cymatogaster aggregatus, Gibbons.	....	Puget Sound	"	"	....	1881	"	1	....
889	26990	Brachyistus frenatus, Gill	....	Monterey, Cal	"	"	....	1881	"	1	....
890	27075	Holconotus analis, (A. Ga.) J. & G.	....	"	"	"	....	1881	"	1	....
891	25065	Holconotus argenteus, (Gibb.) J & G	....	Santa Barbara Cal	"	"	....	1881	"	1	....
892	25077	Amphistichus argenteus, Ag	....	"	"	"	....	1881	"	1	....
893	26885	Amphistichus argenteus, Ag	....	"	"	"	....	1881	"	1	....
894	27017	Hypsurus caryi, (L. Ag.) A. Ag	....	Monterey, Cal	"	"	....	1881	"	1	....
895	27079	Hypsurus caryi, (L. Ag.) A. Ag	....	"	"	"	....	1881	"	1	....
896	27014	Ditrema jacksoni, (Ag.) Gtr	....	"	"	"	....	1881	"	1	....
897	26987	Ditrema atripes, Jor. & Gilb	....	"	"	"	....	1881	"	1	Type
898	26988	Ditrema furcatum, (Grd,) Gtr	....	"	"	"	....	1881	"	1	....
899	27018	Damalichthys argyrosomus, (Gd.) J. & G.	....	"	"	"	....	1881	"	1	....
900	26972	Genyonemus lineatus, (Ayres) Gill.	....	"	"	"	....	1881	"	1	....
901	26873	Umbrina xanti, Gill	....	Santa Barbara Cal	"	"	....	1881	"	1	....
902	26753	Cynoscion parvipinnis, (Ayres).	....	San Diego, Cal	"	"	....	1881	"	1	....
903	26754	Serranus nebulifer, (Grd.) Steind	....	"	"	"	....	1881	"	1	....
904	26910	Stromaleus simillimus, (Ayres) Gill.	....	Santa Barbara Cal	"	"	....	1881	"	1	....
905	26838	Trachurus plumieri, (Lac.) J. & G.	....	San Pedro, Cal	"	"	....	1881	"	1	....
906	25035	Atherinops affinis, (Ayres) Steind	....	Santa Barbara	"	"	....	1881	"	1	....
907	26766	Leuresthes tenuis, (Ayres) J. & G	....	San Diego, Cal	"	"	....	1881	"	1	....

908	26907	Exocætus californicus, Cooper......	....	Santa Barbara Cal	Alc'hol	U. S. Fish Com..	....	1881	U. S. Nat. Museum	1	....
909	27136	Osmerus thaleichthys, Ayres.......	....	San Francisco Cal	"	"	....	1881	"	1	....
910	27259	Salmo purpuratus, Pallas, (Salmo clarki, Rich........................	....	Puget Sound......	"	"	....	1881	"	1	....
911	26786	Stolephorus delicatissimus, (Grd.) J. & G............................	....	San Diego, Cal....	"	"	....	1881	"	1	....
912	26785	Stolephorus compressus,(Grd.)J & G	....	"	"	"	....	1881	"	1	....
913	24886	Clupea sagax, Jenyns..............	....	"	"	"	....	1881	"	1	....
914	27283	Mylochilus caurinus, (Ricn.) Ag....	....	Columbia River...	"	"	....	1881	"	1	....
915	27226	Chimæra colliæi, Bennett...........	....	San Francisco, Cal	"	"	....	1881	"	1	....
916	.....	Colosoma, sp. ?, etc..................	....	Minnetonka......	"	C. L. Herrick....	1877	1877	C. L. Herrick......	Ind	* ....
917	.....	Coccygus erythrophthalmus, Wils..	....	Minneapolis......	"	"	June 17, '78	1878	"	1	† ....

*From the gizzard of swallow-tailed kite. †Nestling, half grown.

CATALOGUE OF ARCHÆOLOGICAL SPECIMENS IN THE GENERAL MUSEUM.

1. Flint arrow point from near Bismarck. Presented by Col. C. A. Lounsbury.
2. Chert implement, unfinished; from near Bismarck. Presented by C. A. Lounsbury.
3. Quartz chippings (fine), Little Falls, Minn. Collected by N. H. Winchell.
4. Quartz chippings (coarser), Little Falls, Minn. Collected by N. H. Winchell.
5. Quartz chippings (coarse), Little Falls, Minn. Collected by N. H. Winchell.
6. Chert implement, "finished." Mouth of the Little Elk River, near Little Falls. Collected by N. H. Winchell.
7. Quartz implements, Little Falls, Minn. Collected by N. H. Winchell.
8. Copper spear-point. Medicine Lake, near Minneapolis. Presented by Henry W. Howling.
9. Stone hammers, from the ancient mines of Isle Royale. Collected by N. H. Winchell.
10. Charred wood, from the ancient mines of Isle Royale. Collected by N. H. Winchell.
11. Pounded copper flakes from the ancient mines of Isle Royale. Collected by N. H. Winchell.
12. Three human skulls from the mounds at Big Stone Lake. Collected by N. H. Winchell.
13. Blue-glass bead, from the mounds at Big Stone Lake. Collected by N. H. Winchell.
14. Perforated bone disk (bead?), taken from the mounds at Big Stone Lake by N. H. Winchell.
15. Red Catlinite pipe, from the upper Minnesota River, formerly ownedby Mireall and Roberts. Presented by N. H. Winchell.
16. Indian pipe, of the "pipestone" at Fort Francis. Collected by N. H. Winchell.
17. Burnt clay pipe, from the mounds opened near Lanesboro. Presented by B. A. Man, Esq.
18. Photograph of clay image of the human face, found in the Lanesboro mounds. Presented by G. K. Day, Esq.
19. Flint chips and shells, from the Atlantic coast near Salem, Mass. Collected by C. W. Hall.
20. Stone hammer, withed, from near the Lower Agency on the Minnesota River. Collected by N. H. Winchell.
21. Collection of arm and leg bones, including one perforated *humerus*, from the mounds at Big Stone Lake. Collected by N. H. Winchell.

22. Lot of human teeth taken from the mounds at Big Stone Lake. Collected by N. H. Winchell.

23. Miscellaneous bones and fragments of bones, mostly human, from the mounds at Big Stone Lake. Collected by N. H. Winchell.

24. Pottery fragments, from near Bismarck. Presented by Col. C. A. Lounsbury.

25. Arrow heads, from Spring Valley, presented by John Kleckler.

26. Chippewa bark canoe and two paddles made at Grand Portage, Lake Superior; used by the Geological survey. Collected by N. H. Winchell.

27. Human femur from a mound, Sec. 6, Rutland, Martin county. Collected by Warren Upham.

28. Portion of a skull and jaw from a mound, Sec. 6, Rutland, Martin county. Collected by Warren Upham.

29. Left ramus of jaw, from a mound, Sec. 6., Rutland, Martin county. Collected by Warren Upham.

30. Pottery, probably by recent Indians, E. side of Talcott Lake, 1—2 ft. below the surface. Land of Wm. Crapey, ne ¼ sec. 30, Southbrook, Cottonwood county. Collected by Warren Upham.

31. Human skull, from a mound, Green Lake, Kandiyohi county. Collected by C. M. Terry.

32. Fragments of two human skulls, Green Lake, Kandiyohi county. Found in a mound. Collected by C. M. Terry.

33. Fragments of leg bones, Green Lake, Kandiyohi county. Collected by C. M. Terry.

34. Water-worn pebble (supposed to be wrought by man), Green Lake, Kandiyohi county. Collected by C. M. Terry.

35. Teeth and bones of (buffalo?), Green Lake. Collected by C. M. Terry.

36. Arrow-head of flint, Rochester, Minn. Presented by W. D. Hurlbut.

37. Quartz arrow-head chippings, (unassorted), Pike Rapids. Collected by N. H. Winchell.

38. Quartz fragments and chippings (also two pieces of gneiss), dug from the alluvium at Little Falls. Collected by N. H. Winchell.

39. Flint arrow-head, Medicine Lake, Hennepin county?

40. Pottery, bones, piece of skull, etc. In black soil 1½–2½ feet below the surface, Green Lake, Kandiyohi county. Collected by Warren Upham.

41. Bones, pottery, chipped flints, Green Lake. Warren Upham.

42. Hatchet (recent) made of Catlinite.

43. Gunflints, (2 spns.) Found at Gunflint Lake in 1878, by N. H. Winchell.

44. Gunflints, Oxford Mills, Canon Falls, Goodhue county. Collected by N. H. Winchell.

45. Bones, pottery, etc., Green Lake. Warren Upham.

46. Human *ulna*, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

47. Foot bone (great toe), from mounds near St. Peter. Deposited in the museum by J. Blackiston.

48. Finger bone (had a ring on) from mounds near St. Peter. Deposited in the museum by J. Blackiston.

49. Fragment of *radius*, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

50. Silver wristlet, stamped "Montreal" and "B C," from mounds near St. Peter. Deposited in the musem by J. Blackiston.

51. Two copper ear pendants (tubular, one has hair in it), from mounds near St. Peter. Deposited in the museum by J. Blackiston.

52. String of thirty, small, white china beads, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

53. One large, brown, glass bead, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

54. Four common pins, from mounds near St. Peter. Deposited in the mu seum by J. Blackiston.

55. One sewing needle, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

56. Pearl ornament, somewhat heart-shaped, from mounds near St. Peter. Deposited in the museum by J. Blackiston.

57. Quartz, arrow point (opaque white), from mounds near St. Peter. Deposited in the museum by J. Blackiston.

V.

LIST OF BOOKS IN THE LIBRARY OF THE GEOLOGICAL AND NATURAL HISTORY SURVEY.

Journal of the Academy of Natural Science of Philadelphia. 1817 to 1840. Eight volumes.

Proceedings of the Academy of Natural Sciences of Philadelphia. 1841 to 1878. Thirty volumes.

Journal of the Academy of Natural Sciences of Philadelphia. New series, 4to. 1847 to 1881. Eight volumes.

British Palæozoic Rocks, and Fossils. Sedgwick & McCoy. 4to. 1855.

Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology. 1846 to 1872. Four volumes.

Transactions of the Geological Society of Glasgow. Palæontological series. Part I.

The Silurian Brachiopoda of the Pentland Hills. Thomas Davidson.

Owen's Odontography. Text and Atlas. Two volumes. 1840–1845.

The Geological Survey of New York. Annual Reports for the years 1837, 1838 and 1840. Two volumes.

Transactions of the Geological Society of Glasgow. Vol. 1, Part II. On the phenomena of the glacial drift of Scotland. By Archibald Geikie.

Transactions of tho Academy of Science, St. Louis. Vol. IV, No. 1, 1880.

Owen's Geological Survey of Wisconsin, Iowa and Minnesota. One volume 4to.

The Canadian Naturalist and Geologist. Vols. I to VIII. 1853 to 1863. Montreal.

The Canadian Naturalist and Journal of Science. Vols. I to VIII. 1864 to 1875. Montreal. [Vol. 4 has only Nos. 1, 2 and 4. Vol. 6 has only Nos. 1, 2 and 3.

Traite de Palæontologie. Pictet. 2d Edition. Paris 1853. Four volumes, 8vo and 4to Atlas.

Publications of the Palæontographical Society. London. Thirty volumes, 4to. From 1848 to 1876. (31 vols. as issued.)

Murchison's Silurian System, 4to; and case with large map.

Russia and the Ural Mountains, 4to. Vol. 1, Geology. Vol. II, Palæontologie

VI.

THE WATER SUPPLY OF THE RED RIVER VALLEY.

Since the examination of this important subject in 1877, and the discussion in the report of that year, very general attention has been given to the ways and means of obviating the difficulties. In a great many instances the same methods of curbing wells with pine planks, attended by the same serious consequences, have been followed, but the more enlightened well-diggers, and the proprietors of large farms have generally abandoned that manner of curbing wells, and have resorted to tiling or brick, or to iron tubing; and in numerous cases deep wells have penetrated the drift to that depth where a supply of non-alkaline water has been reached, having an artesian overflow,

At South Crookston, Mr. E. S. Corser bored to the depth of 190 feet, penetrating through the blue clay into coarse sand, or fine gravel, affording sweet, cool water, quite soft, which rises ten feet above the surface, through a three inch pipe at the rate of three pailfuls per minute.

At Lockhart, Polk county, Mr. O. E. Spear has sunk four wells which supply artesian water. That on the Lockhart farm is 140 feet deep; it has a great pressure upward, the water rising, when unconfined, in a four-inch tube to the height of five feet above the surface of the ground.

The artesian "salt well" at St. Vincent was sunk by the St. Paul and Pacific railroad company, the work being done by Mr. O. E. Spear, of Minneapolis. Respecting the strata passed through, and the position of the well, the following communication from Capt. Edward Collins, of Fort Pembina, gives full particulars. A sample of the water of this well is being analyzed by the survey, and will be reported in a general report on the *Hydrology of the State.*

FORT PEMBINA, D. T., January 20, 1881.

N. H. Winchell, State Geologist, Minneapolis, Minn.

SIR; In response to your communication of the 8th inst., I have the honor to enclose herewith a trace of a drawing, showing the section passed through in boring the artesian well at St. Vincent, Minn.

The well has been stopped to prevent the flow of salt water, and a specimen cannot be sent as desired. Some idea of its character may be inferred from the fact that a dish holding one inch in depth, measuring five inches across the top and three inches across the bottom left upon evaporation about ⅛ of an inch in thickness of a deposit, perfectly clear and reported by the assistant surgeon at the Post (Dr. H. O. Perley. U. S. A.) as chiefly made up of common salt with a mixture of lime and magnesia. The altitude to which it would rise was not ascertained. It flowed over the pipe at about the rate of a common water bucket in something less than a minute as nearly as can be recollected. The water was clear; temperature judged not far from 50° and effervesced slightly upon coming to the air.

The stratum of limestone concrete was easily drilled and the pipe was forced after it with great difficulty, injuring it at the bottom in so doing. A smaller pipe should have been inserted and carried through this deposit. The stratum of gravel underneath was very loose and dry, the pebbles identical with those found in connection with the Cretaceous deposits on the Missouri river.

The sand in which the water was found appeared the same as that on each side of the valley where it meets the table land.

The nearest salt water is in a small tributary of the Red River from the west a few miles south of this point. This stream coming into the valley fairly fresh, though somewhat alkaline, emerges from a small lagoon, very salt, having had apparently, at this point, some communication with the salt deposit, which appears to underlie the valley.

No trace of any organic body could be seen in any of the strata penetrated. They are considered as of the Cretaceous period.

Water is found by the settlers generally by digging a few feet in the marly subsoil. It is nothing but surface water, though it can be, and is used for all domestic purposes. The best water in the valley is from the Red River itself, and this is really good water, nor is there likelihood of finding any other source of supply except by boring very deep artesian wells or storing rain water in cisterns.

It is hoped the experiment of sinking a well far enough to strike a supply of pure water will be undertaken.

Please acknowledge receipt.

Very respectfully,

Your obedient servant,

EDWIN COLLINS,

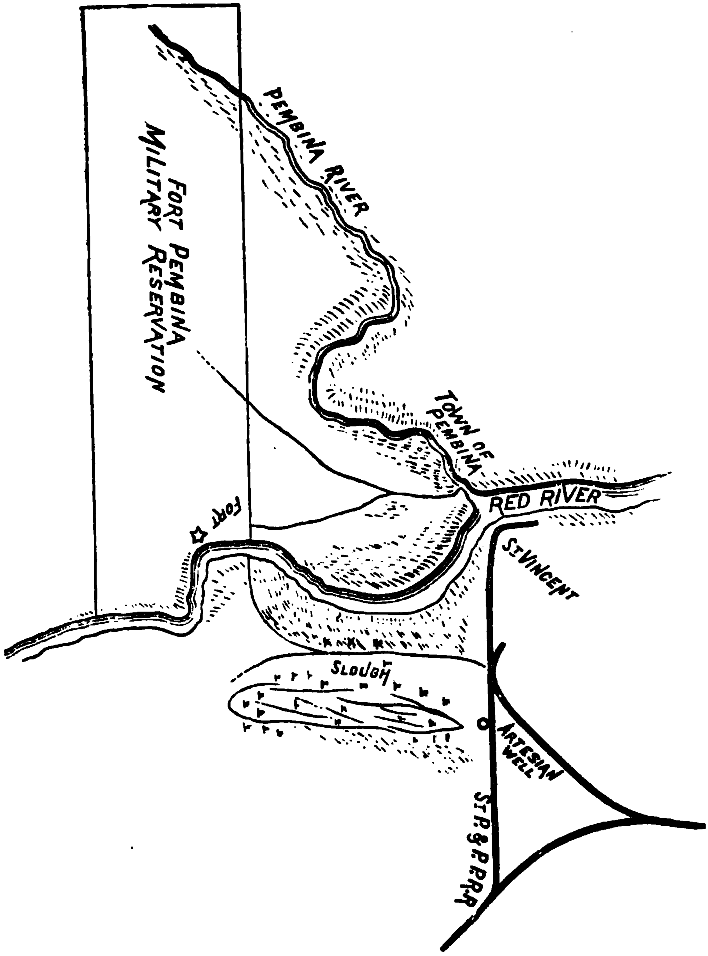
Captain 17th Infantry.

Commanding Post.

Section showing deposits in the Red River Valley, near Fort Pembina, D. T. as found in boring for water at St. Vincent by St. P. & Pacific R. R. Co., Jan. and Feb., 1879.

Scale—one inch to 30 feet.

Road Bed of St. P. & P. R. R.	0
Filling.	5
Alluvium.	3
Pale, drab-colored, clayey marl, very compact and uniform throughout its whole thickness until near surface of underlying rock when a few lime pebbles were noticed. No water in any part.	112
Limestone concrete, containing water-worn pebbles—soft, easily drilled.	15
Made up of hard and soft pebbles and sand, some flint interspersed.	10
Clay, compact, blue.	4
Sand, very loose ; mixed with pebbles ; containing water flowing to top of pipe, very salt and unfit for use.	16
	165



This water seems not, according to Dr. H. O. Perley, U. S. A. at Fort Pembina, to be a pure brine of chloride of sodium, but contains, along with sodium, a considerable quantity of magnesium and calcium. In other words it is one of the alkaline waters of the valley.

At Audubon station two wells have a depth of sixty feet. One is the town well and the other is that of Wm. H. Irish. In these the water rose nearly to the top, but does not overflow.

On sec. 28, Hamden Becker county, the well of John Croll, 75 ft. deep, supplies water that rises 14 ft. above the surface. Another three miles further north, owned by E. N. Jellum, has a depth of 100–110 feet, and is also a flowing well

At Glyndon, on the farm of G. S. Barnes, is a well 112 feet deep, in which the water rose 102 feet.

In Wilkin county, Campbell village, the well at the Pacific House is 47 feet deep and the water stands at 6 ft. below the top; and another on sec. 10, T. 130, R. 46, owned by Robert Glover has a depth of 53 feet, and the water rose to within four feet of the top.

The railroad well at Tintah, in Traverse county, is 55 feet deep and is a flowing well, and another 4 miles S. E. of this was formerly flowing. The water of the Tintah well was chemically examined and reported in 1877.

It seems probable that this method of obtaining water will become common in the valley of the Red river of the North. The conformation of the drift deposits is such as to warrant the expectation that over a large area, on both sides of the river, artesian water can be obtained. It is similar to that in northwestern Ohio. The continuity of the till from the Leaf Hills across the valley westward, is like that of the drift sheet in the Maumee valley. The artesian wells at Toledo, and in Defiance county, are exactly duplicated by those at Glyndon and Crookston. The rolling and more gravelly drift of the Leaf Hills furnishes the supply and reservoir for these wells. When the water has once entered below the clay sheet it finds no exit through it upward, and remains under hydrostatic pressure, which forces it upward with great violence when it is released by sinking these wells. While several of these wells have given a non-alkaline water, that cannot be expected of all such wells in the valley.

Simple Tests of the Qualities of Water.

The detection and determination of the mineral and espececially organic of the impurities of water, when carried to ultimate results, is one of the difficult opperations of chemical manipulation; but a few directions can be given to enable any one to make some general distinctions, by means of such reagents as are accessible either at home or at the nearest drug store. These would be of use to those who desire to know something about the nature of the impurities found in the water of their wells, but do not wish to incur the expense of a full quantitative analysis.

*These tests have been selected as the most easily available; with the co-operation and assistance of Prof. Dodge.

1. Solids in Solution.

Lime. This is mostly in solution as bicarbonate, or as sulphate, and is found in nearly all common wells; it is known by the familiar quality which is described as "hard," *i. e.*, with common soap it produces a *second soap* which is precipitated, or floats in flocks in the water. It also becomes evident, when the water is boiled, by the formation of a crust of lime on the interior of the kettle. A chemical test consists in adding a few drops of hydrochloric acid, then a few drops of oxalic acid (2 drms. in 2 oz. water, cost 10 cents,) and then aqua ammonia, when a white precipitate is formed.

Iron. If a well contain chalybeate water, which is also commonly the case in gravelly districts, it has an "irony" taste, and on repeated evaporation on a plate will leave a rusty sediment. The evaporation is best performed in a teacup placed in a tin cup of boiling water on a hot stove. The brown residue is mostly oxide of iron. To confirm this, add to the residue a drop or two of pure hydrochloric acid, than a drop of ferrocyanide of potassiun; a blue color and a precipitate is produced. (for solution of ferrocyanide of potassium, 2 drams, in 2 oz. distilled water; cost about 12 cents). Water may contain as much as two-tenths grain of iron per gallon, without being injurious as a drinking water.

A delicate test for iron in water consists in stirring a quantity of the water, in a porcelain dish, with a glass rod previously moistened with sulphide of ammonium If the water becomes colored or turbid, it contains either lead, copper or iron. If a few drops of hydrochloric acid then be added, and the color disappears or is sensibly reduced, the water contains iron; but if not, the coloration was produced either by lead or copper.

Lead and copper. The above test for iron will determine the presence or absence of these metals. If lead, copper aud iron are all present, the coloration will be reduced somewhat, but will not wholly disappear. [Sulphide of ammonium solution 2 drams, with bottle should cost about 20 cents. The bottle should have a dark paper pasted all around it.]

Alkalies and Alkaline Earths. In most of the surface and well-waters of the western part of the State, particularly in those parts where the "blue clay" exists, the product of the glacial epoch, is found a greater or less amount of either soda or potassa, as well as of the alkaline earths, lime and magnesia. These are derived from the clay, or glacial-drift deposit that covers that part of the State,

as well as much of Iowa, Nebraska and Dakota. To the drift they were supplied by the Cretaceous clays and shales which by their disintegration have so largely augmented the impervious drift-sheet in those States. They came originally from the waters of the alkaline ocean, which deposited the Cretaceous rocks These alkalies (soda and potassa) if present in observable or objectionable quantities, can be detected by the taste. They cause a soapy, or alkaline, or somewhat nauseating taste in the water. Persons who are addicted to the use of such water soon lose the ability to distinguish these alkalies, and they may experience little or no injurious effects; but a novice is at once struck with the peculiar taste, and perhaps suffers a derangement of the disgestive system if he persists in drinking the water. Such waters are not odorous. Water containing these impurities only is clear, and to the sight and smell is very inoffensive. It is when they come into contact with vegetation, or any organic substance, that they become the cause of rapid chemical reactions that result in foul odors. The organic acids replcae the acids in combination with the alkalies, and sulphuretted hydrogen, and perhaps other gases, are set free to permeate the water or to pass away in the air. The special chemical tests for proving the presence of soda or potassa are rather too complicated to be of service to the non-professional well-owner. If a more delicate examination is desired several gallons of the water must be sent to some practical chemist. If the water has a bitter taste, like epsom salt, it shows the presence of sulphate of magnesia.

2. Organic Impurities.

The presence of organic impurities in the wells of the prairie portion of the State is very common. These do not come from the clay in which the wells are dug, but from the pine curbing or some other local, and generally removable, cause in the surroundings of the well. Sometimes a long wooden tube, serving for a pump, is the source. The supply of these organic impurities is provoked and hastened by the prevailing alkaline qualities of the waters. (*See the sixth annual report for a full discussion of the water supply for domestic uses in the western part of the State*). These organic impurities are the chief source of danger to the farmer, as they have been the cause of hundreds of cases of typhoid fever. If the organic impurities are odorous and very offensive, or if the water contain sulphuretted hydrogen, the fact may be shown

by throwing into a tumblerful a pinch of sugar of lead, when the water will become black.* If the organic impurities are not odorous, so as to attract attention, still their presence may be detected by what is known as the "ammonia process." This method is in general use among water analysts, though the "permanganate process" is also employed, the latter being the more simple, but the former the more delicate and correct. For the purpose of the well-owner it is best to state here only the permanganate process. A dilute solution of permanganate of potash is to be added to a tumbler nearly filled with the water to be tested. If the water is free from organic impurities, the coloration of the water by this addition, will be permanent; but the clarification of the water, in a moment, indicates the presence of organic poison. The greater the amount of the permanganate necessary to produce continued coloration the greater the impurity of the water.

Another test for organic matter, but which is not fully reliable, is to heat on a teaspoon some of the matter obtained by evaporation in a tea-cup; if it blackens and then whitens again, organic matter is shown.

3. Gaseous Substances.

Sulphuretted Hydrogen. As already stated for the detection of odorous organic impurities, as they generally occur in wells in the western part of Minnesota, in connection with alkaline mineral ingredients, this gas can be shown, not only by the smell, but also by the sugar-of-lead test. But there are some wells that are genuine sulphur wells, or sulphur springs, that derive free sulphuretted hydrogen from the rocks underlying, and contain no noxious organic matters. The test here may be the same. Further, such waters will cause a blackening of the metallic dippers and pails in which it is handled. Such waters are not noxious, but constitute some of the famed mineral waters of the country.

Carbonic acid. (Most commonly with lime). Add clear lime water. There will be a white precipitate which will dissolve on adding a little hydrochloric acid.

Carburetted Hydrogen. Besides the odors that arise from wells contaminated by organic decay, the principal gas from which is sulphuretted hydrogen, there are some wells in western Minnesota that have an odor somewhat different, resulting from the distilla-

*To make this test more reliable, dissolve the sugar of lead first with a little carbonate of soda in distilled water, and pour the solution in the water to be tested. The effect will be the same.

tion of gas from the lignites of the Cretaceous, with which they come in contact. The gas can be distinguished from sulphuretted hydrogen by the fact that the addition of sugar of lead will not cause the water to become inky black.

Chlorine. In the case of wells suspected of contamination by sewerage, the organic matter present is easily shown by the detection of chlorine, which is in state of combination with sodium, forming common salt. Still the presence of chlorine in well waters from the western part of the state, cannot be taken as evidence of the presence of sewage contamination, since some of the mineral, alkaline ingredients are in combination with it in a natural state, sometimes even forming common salt. Add a few drops of pure nitric acid, then nitrate of silver; a white, cloudy precipitate or turbility will result. [For solution of nitrate of silver, obtain 1 dram in 1 ounce of distilled water; cost, with bottle, about 25 cts; pure nitric acid 20 cts.]

Sulphuric Acid, [most commonly with lime or magnesia.] Add a few drops of pure hydrochloric acid; then chloride of barium; a white, heavy precipitate will form. [For solution of chloride of barium, get two drams, in two ounces of distilled water; cost about 10 cts; pure hydrochloric acid, 15 cts.]

VII.

THE UPPER MISSISSIPPI REGION.

A REPORT BY O. E. GARRISON.

Prof. N. H. Winchell, State Geologist:

SIR; In the following report I will give a succinct narrative of the journey taken by me during the past summer to explore the head waters of the Mississippi R. in the interest of the tenth census of the United States, Dept. of Forestry.

This paper is compiled from notes made in pursuance of instructions given in your letter of the 23d of June 1880. In the accompanying map I have included the country traversed and have endeavored to represent the surface geology of the region as observed at various times during the last 20 or 23 years.

With one assistant as canoe man and man of all work, I left St. Cloud via Northern Pacific R. R. June 28, 1880, arriving at

Camp No. 1, Verndale, Wadena County,

on the same day, at which place we remained two days, taking notes of the forests, etc. Your own published observations render any of mine superfluous. Leaving Verndale we put canoe in the Wing R. at about one mile from the station near where a mill was in process of erection. The dam gives about 10 feet head and the excavation for the foundation exposes the stony clay so often described at about 10 feet below the surface which here consists of a sandy and gravelly clay.

Camp No. 2, Wednesday, June 30,

was pitched on a spot of gravelly clay 10 feet above the flood plain thrown up in digging a mill-race, near where the line of Tps. 134

135 crosses the river. The dam having been carried away, the site is now abandoned. In the race the boulder clay appears near the surface which is a rolling sandy and clayey loam. The timber consists of scattering black pine, *Pinus banksiana*, small Norway pine, *P. resinosa*, with a new growth, chiefly of deciduous varieties, as black and burr oaks aspens and birches.

Camp No. 3, Thursday, July 1.

Entered Leaf R. at 9½ A. M. and the Crow Wing at 4 P. M. The Leaf R. seems to be, approximately at least, a dividing line between fine stratified sand on the north, and sandy or gravelly clay on the south. I took occasion to examine an old fortification which I discovered and surveyed in 1869 of which I enclose a sketch showing plan and elevation (*Fig. 1, Plate 1*). Some three or four miles north of this place I discovered what appears to be evidence of a former settlement. I think these are the sites of a winter camp of one of the early explorers of this region.

The flood plain of the Leaf R. has an average width of 60 rods and is thickly covered by a growth of deciduous trees. while the conifers occupy almost exclusively the upland. The timber on the bottoms is chiefly elm, oak, soft maple, ash, and ironwood, while by far the most abundant among the conifers is the black pine, *Pinus banksiana*. The river at its present stage is from two to four feet below the surface of the flood plain. Camped on a bluff 15 or 18 feet above the Crow Wing R. in sec. 1, T. 134, R. 33.

Camp No. 4, Friday, July 2.

About a mile above the Farnham Brook is a bluff 42 feet high, where a recent land slide reveals the character of the drift. The top consists of a layer, 3 or 4 feet thick, of sand with no large pebbles mixed with vegetable mould; below is a layer of white sand 2 ft. thick followed by a layer of 6 feet of coarse sand and gravel with rounded pebbles. A layer of quicksand 6 or 7 feet thick rests upon the boulder clay which extends below the river bed.

The surface is rolling with few large boulders. Camped in sec. 2, T. 135 N., R. 33 W.

Camp No. 5, Saturday, July 3.

Soon after leaving camp No. 4 the river changes radically in the nature of the channel and bluffs. The former is obstructed by

bowlders while the current becomes quite strong. The bluffs are sloping, and closely wooded and strewn with bowlders of granite, horblende and occasionally of limestone. The country retains the same general aspect as below. Groves of Norway and occasional white pine are interspersed among the characteristic black pine. There are also a few burr and black oaks. On the bottoms are the ash, elm, oak, aspen, spruce, balsam, fir. soft maple etc. In sec. 3. T. 136 N., R. 33 W. on the left bank of the river near the head of a rapids are two ancient mounds. I landed and made the following rough measurements: The one nearest the river is 56 paces from the top of the river bank, here about 12 ft. high; its longest diameter is nearly parallel with the course of the stream; the shape is oval, the longer diameter being 45 ft. and the height 4 ft. The second mound is 33 paces farther west, having about the same size and direction as the first, but is somewhat higher. North of both is a depression as if the earth had been excavated in making them. The soil is sandy with no boulders except in the river channel where they are large and numerous. Camped in sec. 5. T. 136, R. 33.

Camp No. 6. Sunday, July 4th.

Lay in camp all day. The bluffs have continued to decrease in height since leaving Camp No. 4, where they were from 30 to 50 feet high, while here they are only 5 or 6 feet high, with sloping banks, overgrown with grass and hazel. Very few boulders. Many red oak trees 20 to 30 feet high, 12 to 18 inches in diameter with an occasional black oak. A few rods back from the river, the characteristic black pine and sandy rolling surface.

Camp No. 7, Monday, July 5th.

The river retains the same general character as on Saturday, the stoney clay approaching nearer the surface. The oaks, aspens, elm ash are oftener seen on the uplands but the country a short distance from the river is the same as lower down the stream. At about the middle of the afternoon, however, after passing through a tamarac swamp and meadow in the northwest corner of sec. 37 R. 33, we found the bluffs higher, 10 or 20 feet above the flood plain. The flood plain is 40 to 60 rods wide, covered with willow thickets. About 80 rods east of camp, is a sink hole similar to those found in limestone countries, 30 feet deep with water at the bottom, fringed with a dense growth of willow and alder.

Camp No. 8, Tuesday. July 6.

Camp on a narrow neck of land between two lakes in Sec. 6, T. 138, R. 34. The country passed through to-day was similar to that already described until we reached the junction of the Shell and Crow Wing rivers, the former coming in from the west, the later from the north. The country lying north of the one and west of the other is radically different. The surface is quite level or gently rolling with rich, black gravelly loam. The characteristic tree is still the black pine, but there are also many small bur oaks with aspen, birch and ironwood, with small prairies and openings. These openings have a character peculiar to themselves. As throughout the west the bur oak openings were considered choice locations by the early immigrant, so here the *black pine openings* with the small prairies are the choice places, and are fought for by the different factions of Homestead Protection Societies.

This peculiar tract of country commences near the west bank of the Crow Wing river where it runs south through towns 139 and 140, R. 33, and extends northwest to the range of hills dividing the head of the Otter Tail or Red river from the Shell. The Shell river forming its southern boundary it extends north to a line of hills bearing N. 80° W. and crossing the 10th, standard parallel to the north of Fishhook lake.

Camp No. 9, Wednesday, July 7.

At 8.30 A. M.. we arrived at a settlement known as Mantersburg on section 20, T. 139, N. R. 34 W. Mr. Jaris Howard gives the following data concerning a well sunk by him—depth 36 feet. 3 feet sandy or gravelly loam, 28 feet sand and gravel followed by quicksand bearing water. Other wells reach the bowlder clay at from 32 to 42 feet.

Camp No. 10, Thursday, July 8.

Went by team to Fishhook lake, distance of 9 miles. Eastward from Fishhook R., is a heavy growth of black and Norway pine, but after crossing the river not far from its confluence with the Shell, and ascending a bluff 66 feet high, we entered Fishhook prairie, one of the largest prairies in this belt of openings. The shore of the lake near camp, is sandy with a few water-worn pebbles rarely two inches in diameter. Among the stones I noticed

colored slate of a schistose and sandy nature, sandstone, granite, a few quartz pebbles and perhaps 25 per cent. of limestone pieces.

The following trees and shrubs were noted:

Pinus banksiana, Lamb.
P. resinosa, Ait.
P. strobus, L.
P. mitis, Michx.
Fraxinus americana, M.
F. sambucifolia, Lam.
F. viridis.
Ostrya virginica, Willd
Prunus pennsylvanica, L.
P. serotina, Ehr.
P. virginiana, Marsh.
Virburnum lentago. L.
V. opulus, L.
Corylus rostrata, Ait.
Betula papyracea, Ait.
Populus tremuloides, Michx.
Quercus macrocarpa Michx.
Q. bicolor, Willd.
Q. coccinea, Wang. var. tinctoria.
Ulmus americana, L.
Salix, 3 or 4 species.
Ribes hirtellum, Michx.
R. rubrum, L.
Alnus incana, Willd.
Rhus toxicodendron, L.
R. typhina, L.
Amelanchier canadensis, T. & G.
Zanthoxylum americanum, Willd.
Cratægus crus-galli, L.
C. americana, Walt.
R. nigra, L.
Populus balsamifera, L.

Camp No. 11, Friday, July 9.

We loaded the canoe and crossed the lake to the inlet, which has an average width of about four rods, and a rapid current, while the water is of a whitish color. Many large bowlders covered with a white incrustation, obstruct the channel.

The country north of the lake radically changes in character, instead of a level or gently rolling surface, it is a hilly and broken region, many of the hills are abrupt and 100 to 150 feet high, the hollows occasionally having ponds in them, but generally having a grassy or bushy bottom, mostly of willow and alder. The timber changes to correspond with the surface, the diciduous varieties being in excess of the pines. The conifers are principally Norway and white pines, spruce, balsam fir, &c. About one mile from Fish-hook lake we reach the "falls." Here the water passes over a compact ledge of bowlders and in about ten rods has a fall of 10 feet, necessitating unloading the canoe to carry around. Both above and below the falls are rapids, so that within forty or fifty rods there is a descent of 18 or 20 feet. Hight of a hill near the falls on the left bank, 116 feet by barometer measurement. The rocks in the falls and above, are thickly coated with the whitish incrustation. Entering the lake in T. 141, of R. 34 and 35, we passed near ohe shore, which is thickly strewn with granite bowlders, and camped on a sandy point in section 26, T. 141, R. 35.

Camp No. 12. Saturday, July 10.

Passing up the inlet about 6 rods we reached a second lake and after passing through this we entered another inlet, and after rowing 80 rods and passing a rapids, entered a third lake, on the north shore of which is some good pine, though the decidiuous trees are larger and in greater variety.

Rowing up the western arm of the lake we landed, and guiding our course by compass, undertook a portage to a small lake 1½ miles to the northwest, camping in an opening a little south of the lake.

Camp No. 13, Sunday, July 11.

Remained in camp all day. Blue berries and winterberries are abundant.

Camp No. 14, Monday, July 12.

Much of the day was consumed in portages and searching for Indian trails. The country traversed today was diversified with hills 100 to 150 feet high, among which were occasional pools of water. The trees were chiefly of the different varieties of pine with dense undergrowth of hazel, willow, alder and an occasional black oak shrub.

The soil is a coarse sandy loam with occasional boulders.

Camp No. 15, Tuesday, July 13.

Making our way through several small ponds and inlets with an occasional "carry" through a dense growth of oaks, elm, basswood, aspen, black haw, shadberry, ironwood, hazel, etc., we reached a lake crossed by the line of ranges 35 and 36 of Tp. 142.

From the north end of the lake I was informed a trail is to be found leading to Itaska L., but after diligent search, no trail was discovered, and it was deemed prudent to retrace our steps and make the journey by the wagon road. To the north and northeast is a fine growth of pine, but to the westward the land was burnt over and less thickly wooded. The surface is hilly and rocky, large boulders often covering the ground. Taking a short trip inland, found the timber dense, chiefly white and Norway pine with aspen and a few oaks and maples, the latter only a shrub, 12 to 18 feet high, growing in clumps as if from the

stumps of old trees now wholly disappeared. The surface soil is stony clay.

Camp No 17, Thursday, July 15.

Arrived at 1½ p. m., at Camp No. 10, and waited for one of my men to secure a team to transport our luggage to White Earth Agency.

Friday, July 16.

The whole day consumed in waiting for the promised team, but at evening we engaged a team and driver so as to start to-morrow.

Camp No. 18, Saturday, July 17.

Passed numerous settler's cabins. Of several wells noted, the following description of one sunk by Mr. Samuel Churchill on Sec. 26, T. 140, N. R. 35, is typical—12 ft., sandy loam, about 4 in. sandy clay, 1 ft. gravel and sand interspersed with small, rounded stones, coarse sand to water which was 3 feet deep. Passing the eastern boundary of the White Earth Reservation we enter a level country with rich, sandy loam and no stones. The black pine becomes less abundant, good size bur oak with small aspen and birch and an occasional Norway or white pine taking its place. Five or six miles further on we entered a hilly, sandy tract covered by a thick growth of small black pine, where we camped.

Camp No. 19, Sunday July 18.

Resuming our journey we ascended a hill higher than that on which we camped, and found ourselves upon a level table land, where the soil was less sandy and supported an undergrowth of hazel and alder, while the open spaces were gay with the scarlet and yellow leaves of the painted cup. We there found about two miles of rolling ground where the black pines almost wholly disappear and young dense growth of aspen, birch, oak, ironwood, red, black and choke cherry, shadberry, alden and willow with some Norway pines supply their place. Soon afterwards we passed a rocky ridge with many white pines among the Norway and black varieties.

South of the road was a lake in a steep valley about 75 feet below the road. Hills surround the lake on all sides but the northwest. Descending these hills to the west we entered a rocky rolling country where the timber was more of it of the deciduous kinds with some medium sized white and Norway pines, which increased in size and number till they formed a fine grove of good marketable pine timber. There were also seen some sugar maples and oaks. As we passed on west the maples increased in size and frequency while the oaks, birches and elms, many of them reached a large size. We passed several lakes, on the shore of one of which and in the road near it many small pebbles of limestone were seen quite half of the pebbles being limestone. This lake is in a deep valley; after passing it and crossing its outlet we passed over a high, rocky ridge, where were boulders of a large size, many of them being 4 to 6 feet across on the exposed top. These boulders are mostly granite. No limestone was seen. This hilly rocky tract continued about five miles when the pines gradually thinned out and disappeared, and large oaks, sugar maples, birch, aspen, cottonwoods, balm of Gilead, elm, ash, ironwood, etc., formed a splendid forest. The hills were twenty to forty above the hollows where were occasional ponds or lakes. The soil is a clayey loam, in the level spots, free from stones and wet and muddy, but boulders nearly cover the surface on the sides and tops of the hills. This continues until within one or two miles of the Agency when the tall timber begins to thin out and the most of the trees are bur oak. The hills are less high and steep, the hollows covered with a thick, tall growth of grass forming fine natural meadows. Indian farms were passed, and we soon entered a well cultivated region, the surface gently rolling with but a few stones; soil, a rich black clayey loam.

Camp No. 20, Monday, July 19.

After procuring the needed supplies and directions at the Agency began our return to the Junction of the Itasca road with that upon which we had come. We entered camp at the crossing of what I take to be the principal branch of the Otter Tail R. The following is a list of such trees and scrubs as I have been able to identify during our hasty journey from here to the Agency and back:

Quercus, alba.	Fraxinus americana.
Quercus macrocarpa.	Fraxinus pubescens.
Quercus tinctorea.	Fraxinus viridis.

Quercus bicolor.
Quercus ambiqua.
Ulmus fulva.
Ulmus americana.
Betula papyracea.
Betula nigra.
Populus tremuloides.
Populus monilifera.
Populus balsamifera, var.
Populus candicans.
Viburnum prunifolium.
Viburnum nudum.
Viburnum dentatum.
Viburnum acerifolium.
Viburnum opulus.
Rubus strigosus.
Rubus occidentalis.
Rubus villosus.
Rubus canadensis.
Rubus cuneifolius.
Prunus americana.
Prunus pumila.
Prunus pennsylvania.
Prunus virginiana.
Prunus serotina.
Alnus incana.
Alnus serrulata.
Abies nigra.
Abies alba.
Vaccinium pennsylvanicum.
Acer saccharinum.
Acer dasycarpum.
Acer rubum.
Pinus strobus.
Pinus resinosa.
Larix americana.
Ostrya virginica.
Carpinus americana.
Viburnum lentago.
Sambucus canadensis.
Lonicera grata.
Lonicera parviflora.
Diervilla trifida.
Rosa lucida.
Rosa blanda.
Crataegus crus-galli.
Amelanchier canadensis.
Amelanchier var alnifolia.
Spiraea salicifolia.
Spiraea tomentosa.
Dirca palustris.
Salix, three or four species.
Corylus americana.
Corylus rostrata.
Tilia americana.
Rhus glabra.
Zanthoxy lumamericanum.
Arctostaphylus ura-ursi.
Vaccinium corymbosum.

Camp No. 21, Tuesday, July 20.

After ascending the divide between the waters flowing east to the Shell and Crow Wing rivers and those flowing west to the Otter Tail we reached an Indian village consisting of temporary huts and lodges where the Indians are collecting Senaca snake-root (*Polygala senega*). Many hundred pounds of which are stored in the warehouses of the traders. This camp is situated in Sec. 33 T. 141, R. 37, and the black pine openings extend to the west and north as far as the eye can see.

We were here informed by the trader that no such road as we were told of exists toward Itasca but offered to take our load to a lake about 8 miles north of the camp to which the Indians go with wagon to fish.

I have noticed the lead plant—*Amorpha canescens* for the first time since leaving St. Cloud.

13

Camp No. 22, Wednesday, July 21.

Started by 10 a. m., after crossing the prairie towards the north and disovering a valley about 20 feet deep, we climbed a line of hills bearing about N. 80o W, and about 50 feet above the prairie level. The southern aspect is quite steep and full of boulders. The top is gently rolling sand with a few boulders and timbered with small black pine, which forms quite open woods with undergrowth of hazel, aspen, willow etc, By 1½ p. m. we reached the lake crossed by the line between Towns .141 and 142, section 5 32, the south end of which is over 9 miles from the nearest point on Itaska Lake. The outlet of [the lake is a branch of Fishhook river. The bottom of the lake is in many places of the whiteish color noted when crossing the first lake north of Fishhook Lake. Camped at the north end of the lake in a tall dense growth of sprube, birch, aspen, elm, basswood etc., with a dense undergrowth of hazel, plum, willow and alder. A grassy pond fenced in by an old beaver dam on which our tent is pitched, lies a few rods from the lake.

Thursday and Friday, July 22 and 23,

were spent in making the portage from the lake mentioned above to a pond through which the main branch of Fish Hook R. flows, in T. 142, Sec. 17 and 20. This pond is in a valley diversified by such ridges as are known in Wisconsin as "hog backs." Loading canoe a little to the west of the pond, in the brook, we crossed the pond to its outlet, a comparatively large lagoon-like, sluggish stream filled and overgrown with rushes and lily pads, course nearlv northeast for about ¾ of a mi., when the brook takes a sudden bend to the south, cutting its way through hills 75 feet high, while the valley continues northeast, and a small brook comes from it, joining the larger part at the bend. Here we again packed and carried to a high pine ridge north of the valley.

Camp No. 24, Monday, July 26.

The accidental destruction of part of the stores and equipage having necessitated a delay for repairs we were only able to resume our journey this morning, putting the canoe afloat in the pond north of the ridge, after crossing to the north side of which we began the portage to a lake in Sec. 3, T. 142, R. 36, about two

miles distant. Our journey was through dense woods of black and Norway pine with hazel, alder, willow and aspen undergrowth.

Camp No. 25, Tuesday, July 27.

Completing the carry over a gently rolling country, with gravelly surface with now and then a bowlder of granite, we ascended a rise of about 30 feet and descended about 88 ft. to the shore of the lake mentioned. The lake has several islands whose shores like its own are gravelly. This series of lakes is marked on the old maps as having an outlet to the north and thus flowing into L. Itaska being therefore the ultimate source of the Mississippi. Crossing this lake we encamped at the east end of a trail leading to a lake due west about 30 rods.

Camp No. 26, Wednesday, July 28.

We carried over to the other lake, then paddled slowly near the shore, soon coming to a landing and trail leading north; going on in search of the outlet of these lakes, we passed several low spots in the hills surrounding the lakes (20 to 30 feet high). Failing to find an outlet we returned to the place where the trail leading north was found. Here we had a carry, about forty rods, over a low hill, then a pond 60 or 70 rods, then a carry over another low hill 40 or 50 rods, then a pond 50 or 60 rods, dining among some large Norway and white pines, with oaks, basswood, maple &c.; after dinner a carry of 60 or 70 rods to a pond crossed by the line of government survey between secs. 27 and 34. Near the north end of the pond 50 or 60 rods over the floating bog, northeast of the pond, found the usual marked trees at the beginning or ending of a carry. The trail was easily followed through the swamp, but after leaving the swamp and beginning to ascend a low hill we entered a dense tall growth of birch, aspen, oak, pine, &c., the ground thickly strewn with the remains of a large growth of pinea, many of them still pretty sound, showing there was, but a few years ago, a large pine forest here. To the north about half a mile was seen a grove of Norway pines, still alive, through which it seemed that it would be easier to cut our trail. We therefore went into camp. On the northwest end, among tall tamaracks and the end of the swamp, was an old beaver dam on which was growing a dense thicket of alders and willows. In this dam was an opening about two feet wide, through which was running water about two inches deep. I

followed this brook about twenty rods down a rapid descent, with numerous bowlders where the channel was choked with fallen timber, to a mossy pond, or rather to the mossy bottom of a small pond now dry, which stopped my further progress. I consider this the largest feeder to Itaska Lake worthy to be considerd as the utmost source of the Mississippi River. Our route to-day has been over a gently rolling country, with some large pine trees and an occasional oak, elm, basswood, &c., many bowlders on the hills

Camp No. 27, Wednesday, July 29.

Started to make a trail to Elk Lake. Found the way very brushy and crossed a large swamp, surface gently rolling until within about one quarter of a mile of the lake, when we ascended a hill 50 or 60 feet high, on the top of which I climbed a tree to view the surrounding country. For many miles in all directions but the north the surface was gently rolling, none of the hills appearing to be more than twenty or twenty-five feet high; they were chiefly covered with a young growth of birch, aspen and a few oak. Towering above them were seen the black pines, not killed by fires, and an occasional single tree or small groves of Norway pine, towering still above these. These fires which so devastate and utterly ruin so many thousand acres of large pine forests are said to be set by the Indians, purposely, and assisted to spread, to kill the timber, and so give better feeding ground for the moose and deer which abound in this vicinity. The swamps are covered by a large growth of tamarack, spruce and balsam fir. Saw several mountain ash, and there were large tracts covered by the juniper, *Juniperus sabina,* now with ripe fruit. Very few boulders were seen on our route. Directly north of the tree on which I was then was a low spot concealed by a grove of Norways, where was Elk Lake and to the north of this, Itaska. By 1 P. M. we had cut a trail back to camp and, after dinner, carried our first load over to Elk Lake, where we arrived just in time to put up tent and keep dry during a smart shower.

SERIES 2.

Camp No. 1, Friday, July 30.

Completing the portage, by 3 P. M. we were on Elk Lake, steering for Itaska, about one mile distant, as indicated by an open

space in the line of low hills. The outlet was soon found; the water was low and a few rods down from Elk Lake the canoe stranded on the pebbly bottom of the brook; landing and ascending a low hill on the left, Itaska Lake was seen for the first time, about forty rods north. The hill or mound-like elevation is of an oval shape about twenty feet above the lake, and is near the center of an open space, between Elk and Itaska Lakes, of about twenty-five or thirty acres. Several pits on the sides or top had the appearance of old cellars and probably indicated where houses once stood, but all traces of timber if any was used in such houses have disappeared and the numerous boles of large oaks strewn over the ground indicates that there could not have been much cultivation. Still many patches free from standing or fallen trees and a thick mat of grass or wild strawberries, covering from one to four or five acres were quite evidence enough to show that there were once Indian gardens here. Between this open space and the lake shore was a line of trees still standing. Carried over to the lake about 40 rods, and embarking on the lake, pitched camp on a point on the west shore.

Camp No 2, Saturday. July 31.

We paddled slowly along the west shore of the northeast arm, stopping occasionally to identify trees. The arm of the lake towards its southern extremity is surrounded by comparatively high hills, the highest probably 75 ft. above the lake. The western shore is badly burned, with but few pine trees standing, and the dense new growth of birches and aspens among the fallen trees makes it a very difficult tract to traverse. The eastern is much less devastated by fire. There is some good pine on the sides of the hills which, near the southern extremity may reach 100 ft. above the lake. The shores of the southwestern arm are low, 10—15 feet high, and closely fringed with spruce, cedar, balsam fir and tamarack. Some boulders were seen, while the east side of the southeast arm is lined with rocks, and the side hills quite covered with fair sized white and Norway pine. At our camp the soil is a sandy or gravelly clay. The shallows entirely round the lake are grown up with rushes, reeds, wild rice, lily and flag leaves to a distance of 10—60 rods from shore.

Camp No. 3, Sunday, August 1.

Starting about 8 a. m., we reached the outlet of the lake where

the Mississippi first takes its name, by 9½ A. M. It is here an insignificant stream of less width than the length of my canoe. There is a perceptible current and 18 or 20 inches of water with a soft muddy bottom and shore: the banks are low and level and brushy, bordered with prairie country with a few black pines. Continuing on, we soon came to where the stream was too shallow to float the canoe and to a width of less than half the length of the canoe, in several places. We had to lift the canoe over sand bars; we also had to cut away several recently fallen trees that obstructed the channel. Numerous old cuttings showed long use of the river for boating, though no fresh cuttings were seen. About two miles from the lake the river enters a tamarack swamp where it has a deep, broad and sluggish channel, frequently nearly closed by a large growth of wild rice of which many hundred bushels could be gathered. In many places the banks were lined with sweet flag, *Acorus calamus,* L., and good meadows of blue joint and red top, *Calamagrostis Canadensis and Agrostis vulgaris*, With., where thousands of tons of hay could be made. This swamp continues for about three miles, but the river meandering through it is more than twice that distance. A short distance after leaving this swamp we came upon a jam of drift-wood which proved to be the head of a falls or rapids, where the river by a series of short leaps over compact ledges of boulders, has a descent of about twelve feet in as many rods.

This was a surprise as I had the impression from all the information I had, that from the Falls of Pokegama up to Itaska Lake, there was no obstruction to the free passage of canoes.

Following down the bank of the river, I found a series of rapids over boulders for nearly half of a mile, when the river enters another swamp of tamarack and spruce, but without the usual meadow on the bank. The trees which had fallen across the river had been cut away, proving its use, for the passage of boats.

The country is rolling, the hills of gentle ascent, except the bluffs on the river where they are steep and, at our camp, forty-six feet high by barometer measurement. The general level is about that height above the river, the highest hill seen would not exceed 25 feet higher. The country is open, low and brushy. with a few clumps of Norway and black pine; boulders of granite are quite plenty on the hill sides; the surface soil is a gravelly clay.

Camp No. 4, Monday, August 2.

"Carried" down to the landing found yesterday and loaded canoe. We soon came to fallen timber obstructing the channel and had to cut our way through many *jams* of drift wood in many places; also boulders so obstructed the channel that we had to get out of the canoe and wade, lifting over the rocks. In this way we made slow progress, and by noon, from the appearance of the country we had not made much more than two miles northing. While cook was getting dinner I went back from the river about half a mile; found the surface quite level. The black pine timber was burned and fallen; the new growth principally birch and aspen, and a few black oaks. The soil is a sandy or gravelly clay. No rocks seen except in the river; the bluff, about 20 feet high. The flood plain is twenty to forty rods wide; the channel of the river two to four feet below the flood plain.

Soon after starting in the P. M. the bluffs increased in hight; the river seems to have cut its way in a narrow gorge, through hills seventy to eighty feet high. Camped on a terrace or old flood plain about fifteen feet above the present channel.

The timber on the narrow flood plain is a tall growth of spruce, balsam, apsen, balm of Gilead, a few oaks, elms, and ash; on the upland are the usual burnt and fallen black pines; on the left is a tamarack swamp about half a mile from the river, while on the right bank there is less burnt land and some good white and Norway pines.

Camp No. 5, Tuesday, August 3.

The stream was found much obstructed by fallen trees and rocks until we entered a narrow tamarack swamp where the water is deep enough to float the canoe. The swamp soon widens to about eighty or ninety rods with meadow near the channel of the river. We took dinner on a point of hard land projecting into the swamp from the left, where there was an old, much used camping place and a trail leading to the northwest. This trail I suppose to be the one leading from the Mississippi to the upper Rice Lake, the outlet of which is Rice river, a feeder of the Red river and about four miles distant. The swamp was wide at this point and below, but in about a mile the bluffs on each side were seen to be ten to twenty feet high and clothed with tall Norway and black pine, leaving a flood-

ed plain about 60 to 80 rods wide. The river has cut a channel in the soft, mucky bottoms from four to six feet deep.

Camp No. 6, Wednesday, August 4.

The river enters a wide meadow and has cut its way in a very crooked channel from four to eight feet deep. I noticed in many places below the black mucky soil, a white clay, of which I have a sample marked No. 1; it was taken from a depth of about 6 feet below the surface of the flood plain in the river channel. The outer bluffs were about 10 to 12 feet high, with many groves of tall Norway pine forming open woods. The soil a sandy loam; and when the river infringes on them shows a stratification. Soon a line of hills appeared in the north, two or three miles distant, the river gradually approaching them and by 9.30 A. M. we reached them. The river has cut its way in a deep narrow valley, the bluffs rising fifty to seventy-five feet above the river, which has a rapid current obstructed with bowlders. The timber on the bluffs, black and Norway, with a few white pines and bur oaks. After passing through these hills about one mile, we entered another broad meadow or savanna, through which the river meanders in a very tortuous way, prevented from reaching the outer bluffs by a tamarack swamp of unknown width. Took dinner on a low projection of dry land in the meadow, in section 28, T. 146, N. R. 35, W. 5th M. From here another line of hills is seen north of east. By 5 P. M. came to the first low bluff on the right bank, in section 34, T. 146, R. 35; here the almost boundless meadow was narrowed; the bluffs, twenty to twenty-five feet high, lined the flood plain to an average width of 60 to 80 rods. Camped on a bluff nearly opposite a small brook, entering the Mississippi from the south, in section 35, T. 146, R. 35. A few oaks were seen on some of the low points of dry land projecting into the meadow through the tamarack, and the river bank was often lined with tall willows, while, in other places, tall reed grass completely closed in the channel.

Camp No. 7, Thursday. August 5.

Soon after starting we entered another broad savannah. This continued until near noon, when another range of hills was entered. Took dinner on a bluff 49 feet above the river, by barometer measurement—the highest seen. In passing these hills there was

an occasional rapid with large bowlders in the channel; deciduous trees are more frequent and of large growth. The flood plain after passing through a narrow valley of about three-fourths mile, again widened and was bounded by bluffs fifteen to twenty feet high. The country is gently rolling with open bushy plains, bearing some small black pines. The soil is a sandy loam, the river often exposes the stratified sand on the banks; for about two miles before camping the flood plains become narrow—40 to 60 rods wide—and in many places are covered with a thick growth of soft maple, elm, ash, oak and aspen. Camped on a bluff of a very regular crescent shape, 49 feet high by the barrometer, section 17, T. 146, R. 33.

The country south of camp is quite level and free from brush, while the many fallen trees, and the tall stumps of many more blackened by fire tell that not very many years ago there was here quite a dense forest of pines; I went back to a couple of rounded hills about half a mile from the river. From the top of these the country for ten to twenty miles was mapped. To the south and west was a gently rolling table land bounded on the south by a range of hills of fifteen or twenty miles distant. To the east and north the land seems to descend with a gentle slope, and is quite level, clothed with a greener foliage of trees than seen since the forests of the Partridge and Wing rivers were passed. To the south and east was a deep valley in which were seen two large lakes. The soil is sandy with a small young growth of birch, aspen, and a few bur and black oaks, while the black, red, sand and choke cherry are plenty, and are now loaded with ripened fruit. Blackberries, strawberries, red and black raspberries were also in abundance.

Camp No. 8, Friday, August 6.

Soon after starting this morning, we passed the junction of a river nearly as large as the Mississippi. At their junction the Mississppi turns at a right angle and takes the course of its tributary. At 9.30 A. M., we entered the first lake through which the Mississppi runs after leaving Itaska. The next lake, the Pa-ma-jig-er-mug of the Indians, and Cross lake of Nicollet, is a larger lake, and the first one seen since leaving Fishhook lake whose shore has not been grown over with rushes, reeds and wild rice, &c. At the inlet of this lake there was also an Indian's farm or garden, where were corn, potatoes, pumpkins, squashes, &c.; his squaw who

came down the lake and landed here, was the first human being we had seen since the Indian left us and canoe with his pony on the 21st day of July last. After crossing this lake, the river is rapid and full of rocks, making at the present low water a difficult matter to run the canoe down without striking rocks. The shores of the river here are sloping, with a flood plain little or no wider than the river channel; the bluffs are from ten to thirty feet high. There are some bur and white oaks, with many elms, ash, balm of gilead, aspen, &c. We here passed a cedar swamp on the left bank. The country is quite level or gently rolling; the soil is a gravelly clay; the sand bluffs of landslide make, have not been seen since the junction of the large stream before mentioned, and the timber is more of it white and Norway pine, with many deciduous varieties. In the P. M. there were fewer bowlders seen in the river, but the water was deeper and the current rapid. For about two hours before camping, the flood plain widened out and formed large meadows with willow and alder. Camped at 7.30 P. M. on a kind of terrace about six feet above the river as it is at this time, where there are many bur and white oaks, and some large Norway and white pines.

Camp No. 9. Saturday, August 7.

The river here soon runs through the north end of a lake. The western line of the great Indian Reservation of the Leech lake, the Winnebigosis and Mississippi bands of Chippeways commences here; and soon after passing the lake we came to an Indian village of bark lodges, at the entrance of a small lake; on the other side of which was seen another Indian village while far to the north was another still. The soil around these lakes appears to be of an excellent quality, producing corn, potatoes, beans, squashes, &c., in good measure, considering the Indian mode of cultivation. Beyond this lake we crossed another that we at first took to be Cass lake, but after about two and a half miles to what we supposed to be the outlet of Cass lake, we passed a narrow point, and the broad surface of Cass lake lay before us. This is the largest lake but one, through which the Mississippi flows until it reaches Lake Pepin, the Winnebigosis being the larger. The banks of lake Cass are low; no hills that I should judge to be over thirty feet high, border the lake; the water was shallow for a long distance from the inlet, Camped about ten miles below the lake. The river here is very much larger than above Cass lake. The bluffs are sloping and

bowlders are often seen on their sides. There are some fair sized oaks, elms and ashes, many large Norway and a few white pines. The black pines are less common, and the shrubs in much greater variety. The phænogamous plants, and grasses are of a ranker growth than seen elsewhere since leaving the black pine openings and woods of the White earth Reservation.

Camp No. 10, Sunday, Aug. 8.

Starting the usual hour, we came in sight of Winnibegosis by 10 a. m. The flood plain widens out to about ½ a mile for near two miles before reaching the lake. We took an early dinner where the river comes to the bluff for the last time before reaching the lake. Soon after entering the lake, we saw to the northeast a number of white specks on the shore; these indicated an Indian village. Steering our course as near as possible for the outlet of the lake and aided by a stiff west wind we crossed the widest part of the lake by 3 p. m., and by 4 p. m. entered the river at its outlet. We found some difficulty in finding the river in the large space filled and overgrown by tall reed grass at the foot of the lake. On the left bank near the outlet on a spot of flat or bottom lands, separated from the river by a marshy strip, fifteen or twenty rods wide, was an Indian village of about a dozen bark lodges with two or three log buildings, one of which had the appearance of being a church. On the right bank opposite the village was seen for the first time since passing the large tributary to the Mississippi on the morning of the 7th. one of the sand slide bluffs revealing stratified sand, with the boulder clay twelve or fifteen feet below the surface. The timber around the lake as seen from the canoe while passing was the usual black with many white and Norway pines, mixed with which were many deciduous trees. On the northeast shore there was a large tract of hard woods which I was desirious to explore, but as the time and expense have already exceeded my estimates, I did not stop. The river after passing the Indian village has a wide bottom or flood plain on which is a tall and dense growth of reed grass, and the channel divides, forming many islands on which is seen nothing growing but that grass. The outer bluffs are sloping, and many boulders were seen on their sides, while the oaks and other deciduous trees are of larger growth than seen above Lake Winnibegosis.

Camp No. 11, Monday, Aug. 9.

The river below our camp of last night, for three or four miles meanders among tall reed grass, the bluffs about half a mile apart; then the flood plain contracts to 60 or 80 rods wide with boulders on the sloping bluffs and in the channel. The flood plain again widens to one half or three miles, and the river winds from side to side through the tall reed grass. The channel is full and overflowing. At the junction of the Leech-lake river, the Mississippi turns at a nearly right angle and takes the course of its tributary. The timber after the Leech-lake river joins, consists more largely of the hard woods; birch, oaks and aspens prevailing. Camped on a bluff about 30 feet high. From the top of the bluff is seen to the north and northeast the low lands surrounding Ball Club Lake, a tamarack swamp concealing the lake from view, while to the east and southeast stretches a large marshy meadow of many miles in extent, over which a line of hills, blue in the distance, indicates the hilly region in which is situated Deer and Bass lakes, where is said to be many millions of feet of peculiarly fine white pine. Far to the north of our Ball Club Lake the low lands extend to Bowstring Lake through which the Big Fork river runs in its course north to the Rainy Lake and River. Mr. J. P. Hinchelwood, a former U. S. Deputy Surveyor informs me that from a point near the southern most part of the latter lake, there is low ground extending south, where during high water there is a water connection with a river that runs west and north entering Lake Winnibegosis at its northern extremity.

Camp No. 12, Tuesday, Aug. 10.

Soon after stsrting we entered the great morass and meadow on the north and west of White Oak point; passed the point at 10 a. m., stopping a few minutes to examine the surface and timber. There was here, a few years ago, a prosperous Indian settlement.

When Jas. Whitehead was the Indian Agent he had his residence here. Leaving the savanna about 12½ p. m., found the first accessible landing on hard ground, except at the White Oak point, since leaving the camp in the morning. Hundreds of tons of hay are now being put up by the Indians and half bloods, for lumbermen. Took dinner at an old log landing, where I gathered a rich harvest of specimens. There were more deciduous trees and of a thrifty growth than seen at any place on the river hith-

erto. At 4 p. m. passed a lumberman's camp and farm, where was a white man seen for the first time since leaving the trader's camp in the southeast corner of the White Earth reservation.

The banks of the river passed after dinner were of an average of 80 or 100 rods apart. In some places the flood plain widens to half a mile or a little more. Only in two or three places during the day were boulders visible in the river channel or on the bluffs. The bluffs were mostly low, six to fifteen or twenty feet high, clothed with live thrifty trees, the principal kinds being white and Norway pines, birch, aspen, white and burr oaks and a few black oaks, most of the timber being a new growth of fifty to seventy-five years.

Camp No. 13, Wednesday, August 11.

Arrived at Pokegama Falls at 10¼ P. M. taking notes, collecting, &c. Not having an instrument with which to measure the width of the river or accurately take the levels, contented myself per force with barometric hights. According to them the descent from the upper to the lower landing was 31 feet. On the right bank about 80 rods above the place where the rapids commences, sandstone in situ is seen. It is coarse, friable and of a reddish cast. The dip appears to be about 20° S. 75° E., and where the chute is most perpendicular, appears to have been eroded so as to allow the harder rock immediately superimposed to sink at a crack or fault, crossing the channel at nearly right angle, forming the smoother apron-like chute, where the fall is steepest. At its lower end it is broken and loose, where the water meeting with the obstruction rises in waves three or four feet, and then rushes in a boiling current over the loose rocks broken from the strata.

The pen and ink sketch in plan and section will convey a tolerably correct idea of the Falls and the strata of which the rock is composed. The numbers corresponding with the same on the paper, in which the specimen is enclosed. (Plate 1, Fig. 2.)

In about half an hour, paddling down the stream, we arrived at Grand Rapids, the head of steamboat navigation above Aitken on the Northern Pacific Railroad.

Above Pokegama Falls, steamboats could readily run to a point some miles above Lake Winnibegosis, also up Leech Lake River to Leech Lake agency. Indeed, in 1875, when Mr. J. B. Bassett was Chippeway Agent he built a small steamboat on Leech

Lake and used it to transport supplies to points above Pokegama Falls. Steamboats were run from Aitkin to this place, making trips as often as a load is obtainable, the lumbermen being the principal freighters. The bluff here is above fifteen feet above the river. The first bench or terrace, on which is built the store and most of the buildings is rocky, while back about twelve or fourteen rods, the land rises perhaps twelve or fifteen feet higher with fewer boulders. The soil is a clayey, sandy loam. The timber is principally pine, of that species or variety which I have often mentioned as *P. mitis,* the "Northern pitch pine." The oldest and most experienced lumbermen note the difference between this and *P. resinosa*; one is called by them Hard Norway, the other the Redbarked Norway.

Camp No. 14, Thursday, August 12.

Spent all of the forenoon collecting and mailing such conifers found in the vicinity not yet sent to professor Sargent. Then in the P. M. ran down to the mouth of Prairie River and up that to the first fall or rapid in Town 56, N. R. 25, W. 4th Mer. In ascending this river after leaving the Mississippi, the current is slow and the water deep, the channel taking a wide bend to the west then sweeps around to the east. On the present point formed by this bend there are some white and bur oaks, ash, elms, aspen, etc. Just at the base of this point the river has a north and south course, and a rapid over a boulder clay exposure. These rapids extend up stream about half a mile, when the river expands in a broad lake-like channel with wide borders of wild rice. For about four miles to near the foot of the lower falls the banks are low and bordered by cedar, aspen, balm of Gilead, oaks, pines, etc. As we approach the rapids below the falls the lake-like channel has many boulders and two or three small islands on which is some grass and shrubs. Owen in the description of Pokegama falls in his report of the geological survey of Wisconsin, Minnesota and Iowa, says that the continuation of the ridge which forms these falls, to the northeast constitutes the divide of the waters flowing north to Rainy Lake from the waters running south to the Mississippi and St. Louis. It appears that neither he nor his assistants were aware of the existence of these falls of Prairie river. The exposure of this rock which occasions the Pokegama falls appears to me to be a part of the same ridge forming the two falls of Prai-

rie river. The rock exposure forming the upper falls, I have traced in a northeast direction over one mile, the upper falls and the lake between it and the lower fall being the result of igneous forces. The sketch of the two falls and lake between them is copied from one made by me from actual survey in August 1869. (Plate II, Fig. 1.)

These exposures of rock have been greatly disturbed and so altered by igneous forces that their dip is very difficult to determine. The only point where the dip is apparent is at the lower fall near the point marked 3 on the plot, where the water glides over the smooth surface at an angle of about 35° toward the south for about six rods; near the foot of this slope was taken No. 102 from the top. which, during high water is beneath the surface. The surface of the water in the upper lake above the rapids is about 10 feet higher than the lower lake. The lower lake is about 15 feet above the surface of the water in the river below the rapids at the landing at the beginning of the carry, making a total fall of some twenty-five feet. The trail from the landing to the lower lake is full of loose rock of altered—metamorphosed—sand stone. Specimen No.   was from near the middle of the carry where the surface of the rock *in situ* was exposed; it was about 8 feet above the water in the lower lake. Near the foot of the lower fall there is a seam or vein of ironstone, Nos. 112, 113 and 114. The course of the vein is about N. 40° E. S. 40° W. and where exposed in the channel of the river lies nearly horizontal, while the dip of the rock is about 15° S. W. At about the middle of the channel where the ironstone is the most plainly revealed there seems to be a fault, over the edge of which the water has a perpendicular fall of about 18 inches while the containing rock retains its dip of about 15°; but both soon after disappear beneath loose boulders to again reappear on the left bank a little below the landing. The width, (10 ft.,) of this vein of iron is quite uniform as far as it is traceable. In the drift on the right bank some parties in prospecting have dug pits in a course in which this vein if extended would be found; the pits are 5 or 6 feet deep, from the bottom of which a specimen was taken.

At the upper fall the rock has been subject to a more energetic disturbance and is broken and dislocated in all directions so that the dip or course of any particular seam is difficult to determine. Many of these cracks are filled with a quartzyte comglomerate (Nos. 109 and 110.) At one point I thought that I saw an injection of trap when surveying in 1869, but after diligent search at this time

failed to find it. I might have been mistaken then but my impression is that such a seam of trap was seen and specimens taken. The river here is contracted to a width of 18 or 20 feet, between perpendicular walls of rock 15 or 20 feet high. To the east of the river and "carry" the rock rises to a hight of about 50 feet above the surface of the water in the lower lake, and the ridge continues in a northeasterly direction, with frequent out-crops of the rock above the drift and soil covering it and then sinks beneath the swamp in section 26. Friday and Saturday were employed in collecting samples in the vicinity of the falls and lakes.

Camp No. 15, Sunday, August 15.

Started from Prairie river falls at 9:30 A. M. After entering the Mississippi, frequently landed on the points formed by the bends of the river in meandering through the wide flood-plain which are densely covered by a large growth of hard woods. On one of these points in town 54, N. R. 24 W. was rewarded in my search by finding a single tree of hack berry, *Celtis Mississippiensis*, Bosc or *C. integrifolia* Nutt.; being without fruit could not decide which variety.

This is the most northerly point where I have seen this species. Mr. J. P. Hinchellwood tells me that when he was U. S. Deputy Surveyor, surveying T. 149, N. R. 26, W. 5th Mer., he saw several of the trees on the flood plains of the Big Fork, a tributary to Rainy Lake. Camped on a bluff 65 feet high by barometer measurement. The country west is a gently rolling, open brushy tract. About half a mile west is seen the remains of a large growth of pine in the shape of tall blackened trunks with a few live trees. The new growth is principally birch and aspen, a few oaks, with cherry, willow, alder, hazel, etc. Very little of it exceeds ten feet in hight while ferns and blueberries dispute for room with the grasses. The following rough sketch will give an idea of the formations as seen on the steep bluff revealed by land slides. (Plate II. Fig. 2).

Camp No. 16, Monday, August 16.

A dense growth of young aspen, birch, alder and willow surrounds our camp, which is on a kind of a terrace, the bluff in about eight rods rising about 15 feet. On our way to-day we saw bluffs from thirty to sixty feet high where the stratification was well

shown which did not vary much from the sketch and description given above. In one place where the river swept around in a very regular curve of nearly half a mile periphyry and quite or more than a semi-circle, the bluff was about thirty-five feet high, and when near the middle of the curve there appeared above the water a bed of very compact clay, which had a dip up stream, the topmost layer continually rising above the water and appearing like a wall of irregular sized brick in regular courses, the courses being very regular. This layer seemed to end on the bluff ascending to a kind of terrace above the flood-plain, the second bluff also terminating some of the upper courses. (Plate II, Fig. 3).

The rough sketch will convey to the mind an idea of the appearance better than any description. The courses as represented are too thick and the dip too great; otherwise it is nearly as it appears from the river. The timber on the higher bluff is principally black and Norway pine and on the flood plain soft maple, oak, ash, elm, aspen, and willow, of which last I saw some large specimens. I also saw butternuts, the first seen on this trip.

Camp No. 17, Tuesday, August 17.

Began our journey at 7½ A. M. The river is very crooked. The timber on the flood plain increases in size as we descend the river. Passed the mouth of Swan river at 4 P. M. There has been a steam mill in operation here since I passed here the last time, but it has been removed with all the machinery, and no residents are here now. Camped on a bluff perhaps fifty feet above the river. There was a crew of hay makers camped there in charge of Mr. Libby, from whom I received much valuable information as to the standing timber in the vicinity. The soil on the left or west bank of the river is more clayey and boulders come to the surface. Cedar, spruce, balsam-fir, etc., are seen in dense woods, and crews of Indians and half-bloods are at work getting out cedar telegraph poles.

Camp No. 18, Wednesday, August 18.

The timber on the flood plain continues to increase in size; saw many large old oaks, ash, elm and aspens, many four to five feet in diameter. The yellow birch and soft maples are many of them three to four feet in diameter.

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Camp No. 19, Thursday, August 19.

Passed the mouth of Sandy river at $8\frac{1}{2}$ A. M. Landed to take a look at the place famous in the history of the early explorers and voyagers. Nicolet, Schoolcraft, Owen, Pike and other scientific explorers of the upper Mississippi in the past one or two hundred years have made this one of the noted places. Here is where they came to or left the Mississippi on their way to or from Lake Superior.

The trail from the West Savanna, a branch of the Prairie river, which at last flows into Sandy Lake, to the East Savanna, a tributary to the St. Louis river, had been used from the time tradition tells not of. A long narrow ridge in a northerly and southerly direction separates the Mississippi flood plain from that of the Sandy, and for several rods above its southerly end both rivers wash the base of the ridge. The Mississippi, where the Sandy joins it takes a bend—as in many other places noticed—and follows the course the Sandy where their waters mingle. The ridge is quite regular in out-line, about fifteen feet above the Mississippi and sixty or eighty rods long, as the north of it expands and rises perhaps fifteen feet higher; and on the southerly declivity are a number of Indian graves. The spot has probably been used as a burial place for centuries. On the ridge are many pits which were once cellars under timber houses, but now there is not a house on the ridge, and only a pit and one or two half-cut-up logs indicate where in 1864-68 Mr. Libby had his house and store.

A few granite boulders are seen on the ridge and where the Mississippi washes the base of the bluff are pebbles of granite, quartz, slatestone, etc., forming a shingle beach.

This region had long been in dispute for possession by the Sioux and Chippeways. Schoolcraft tells of sanguinary battles between them and how the fierce Chippeway warriors of the north finally drove the Sioux from this favored region and took possession; retained it until the pale-face subdued them and finally purchased of them the graves of their ancestors as well as the rich pine forests.

About two miles below the mouth of Sandy river there is a short rapid where the water breaks over large boulders and the shore is rocky.

We camped on one of the few sandy bluffs to be found between the Sandy river and Pine Bluff below Aitken.

Camp No. 20, Friday, Aug. 20.

This morning we felled an oak. *Quercus bicolor*, Willd. Pin oak, or swamp white oak, by both the common names, I have heard it called. This kind of oak is common on the flood plains of the Mississippi above Crow Wing, and flourishes as far north as Lake Winnibegosis also in the woods of Benton, MilleLacs and Morrison counties. Passed the mouth of Willow river at 3 p. m. About two miles below the mouth of Willow river by section lines, but three times that distance by the meanderings of the Mississippi, there is the worst rapids to be found between Pine Bluff below Aitken, and Grand Rapids about four miles below the Falls of Pokegama. Camped on the highest bluff to be found for many miles, in Sec. 28, T. 48, R. 26.

Camp No. 21, Saturday, Aug. 21.

Did not get started until past 8 a. m., when after a hard pull, at 12½ p. m., we entered Mud river. After dinner I went up to Aitkin station, about one mile from the Mississippi, where the Northern Pacific crosses Mud River. This is now quite a village. Made such arrangements as relieved me of the necessity of continuing the journey in the canoe to Brainerd.

Here ends one of the most instructive and interesting canoe journeys of the many that I have heretofore made in the interest of pind land owners or as U. S. Deputy Surveyor surveying public lands. In the following pages I will give a list of all the forest trees and shrubs that I have been able to identify in the region traversed. A map of the country also accompanies the paper on which I have endeavored to mark the limits where some of the most important trees form the characteristic forests.

I wish here to record my obligations to Mr. Thos. C. McClure of this city St. Cloud for his pecuniary assistance without which the journey would not have been made. Also to Mr. Geo. A. Morrison of White Earth, Mr. Wakefield of Grand Rapids, and Mr. C. H. Douglass of Aitkin, all these gentlemen having assisted to the full extent of my needs in the prosecution of the work.

The following is a list of the forest trees identified in the region traversed:

Tiliaceæ.

1. Tilia americana, L, Basswood, abundant.......................... 14

Rutaceæ.

Sapindaceæ.

Rosaceæ.

Cornaceæ.

Caprifoliaceæ.

Thymeleaceæ.

Oleaceæ.

30. " sambucifolia, Lam., Black Ash....155
31. " quadrangulata, Michx, Blue Ash....156
32. " viridis, Michx....157

Urticaceæ.

33. Ulmus alata. Michx, Small leaved Elm(?)....176
34. " americana. Willd, White Elm....177
35. " fulva, Michx, Slippery Elm....179
36. " racemosa, Thomas, Rock Elm....180
37. Celtis occidentalis, L., Hackberry....184

Juglandaceæ.

38. Juglans cinera, L., Butternut....195
39. Carya amara, Nutt, Bitternut....199

Cupuliferæ.

40. Quercus alba. L., White Oak....201
41. " bicolor, Willd, Pin Oak....209
42. " coccinea, Wang, Scarlet Oak....213
43. " macrocarpa, Michx, Burr Oak....227
44? " palustris (?). Du. Roi, Pin Oak....231
45. " rubra, L., Red Oak....231
46. " tinctoria, Burtram, Black Oak....236
47. Ostrya virginica, Willd, Hop horn beam, Ironwood....244
48. Carpinus caroliniana, Walt, Blue Beech....245

Betulaceæ.

49. Betula alba, L. (?) White Birch....246
50. " lutea, Michx, f. Yellow Birch....248
51. " papyracea, Ait, Canoe Birch....251
52. Alnus incana, Willd, Black Alder....252
53. " serrulata. Ait, Smooth Aler....00

Salicaceæ.

54-60. Salix, six or seven species.
61. Populus balsamifera, L., Balm of Gilead....263
62. " canadensis, Ait....00
63. " grandidentata, Michx....265
64. " monilifera, Ait....267
65. " tremuloides, Michx....268

Coniferæ,

66. Juniperus virginiana. Red Cedar....277

The following I have heard of, as growing near Pokegama lake, but I have not seen the trees.

The figures on the right of the names are the numbers in Prof. Sargent's pamphlet of the forest trees of North America.

The Forest Distribution.

In the accompanying map of the upper Msssissippi country, I have endeavored to show the region where there is a decided prevalence of one particular tree characteristic of the tract. The dotted line will very nearly represent the southern and western limits of the tract where the white pine, *Pinus strobus*, is the characteristic tree. It is from the region north and east of this line that the largest quantity of pine lumber manufactured in Minnesota at and above Minneapolis, comes. Besides this characteristic tree I have identified sixty-four species of trees, not counting the shrubs found growing in more or less abundance. in the region of country indicated. In the following table, the numbers in the first column are the numbers in the preceding list; the second column will represent the comparative abundance of the trees, taking 10, the white pine as being in the greatest abundance.

1	3	15	3	29	4	43	4	64	3
2	3	16	1	30	5	44	2	65	5
3	3	17	2	31	2	45	1	66	1
4	1	18	1	32	1	46	4	67	6
5	4	19	1	33	1	47	4	68	5
6	3	20	8	34	3	48	2	69	3
7	2	21	2	35	1	49	2	70	3
8	2	22	4	36	1	50	4	71	3
9	8	23	3	37	4	51	6	72	6
10	3	24	2	38	3	52	7	73	6
11	2	25	4	39	1	53	3	74	3
12	3	26	2	40	6	61	4	75	3
13	5	27	1	41	1	62	8	76	10
14	3	28	2	42	3	63	4		

On the map within the region covered by the dotted line I have marked, by a line of alternate dots and dashes, a tract of land on both sides of the Mississippi, commencing a little to the east of the third guide line on the Mississippi thence in a northeasterly direction, thirty or thirty-five miles, having an average width of about twelve miles. This region is quite level and flat, so much so that the drainage is imperfect, forming extensive swamps of cedar, tamarack, spruce and balsam fir. Here the characteristic tree is the white cedar. It is from this region that the largest number of cedar telegraph poles are procured.

On the flood plain of the Mississippi where the drainage is greatest—the river having a channel in the soft spongy soil, to a depth of 6 to 14 or 16 feet, and pursuing a very torturous course—there is a thrifty growth of oaks, elms, bass, maple, ash, &c.

The plain line will very nearly approximate to the western and southern limits of the pines. There are occasionally pines seen in small groves or single trees south and west of this line, but they are exceptions. The characteristic tree between this line and the plain line, is the black pine, *Pinus banksiana*; the number of species is about the same as in the first region, but their relative abundance as well as their developement, total amounts and thriftiness of growth are different, the geology of the country is less favorable to them. The soil, except in a few limited areas, is sandy, the growth of trees, as well as of the phænogamous plants and grasses, less rank.

There are several tracts of limited extent in this belt that partake of the same geological features found in the first region, and the characteristic trees, the relative abundance and developement agree correspondingly. The largest areas of this character are found about the source of the Otter Tail River. The other and larger, south of the Crow Wing River and west of the Mississippi, includes the Little Elk River and a part of the Long Prairie River.

The following table will very nearly represent the relative distribution of trees in the second region:

1	2	11	1	21	3	31	3	41	2	51	7	68	2
2	3	12	3	22	3	32	4	42	7	52	5	69	2
3	2	13	8	23	4	33	3	43	2	53	2	70	3
4	1	14	2	24	2	34	3	44	7	61	6	71	3
5	3	15	3	25	3	35	2	45	1	62	4	72	6
6	2	16	1	26	2	36	3	46	8	63	2	73	10
7	1	17	3	27	4	37	3	47	4	64	2	74	4
8	3	18	3	28	2	38	4	48	2	65	5	75	4
9	5	19	2	29	2	39	2	49	5	66	1	76	3
10	2	20	4	30	-	40	3	50	3	67	2		

West and south of the plain line commences the belt of deciduous hard woods, mostly covered by dense heavy timber, with some small prairies interspersed. The western and southwestern limits of this tract I have indicated by a line of dashes separated by two dots, and it may be taken the commencement of the great prairie regións, the prairies prevailing with small groves of timber interspersed on its eastern borders.

The following is a list of the trees noted in this belt on the road east of the White Earth Agency:

1	9	10	9	19	2	28	3	37	3	46	1	62	2
2	6	11	2	20	3	29	2	38	3	47	3	63	2
3	3	12	5	21	3	30	4	39	3	48	2	64	1
4	3	13	2	22	2	31	1	40	4	49	2	65	4
5	2	14	3	23	2	32	5	41	4	50	3	..	..
6	3	15	6	24	1	33	1	42	4	51	3	..	..
7	3	16	1	25	3	34	4	43	6	52	3	..	..
8	3	17	4	26	2	35	2	44	2	53	3	..	..
9	2	18	5	27	4	36	2	45	2	61	3	..	..

SHRUBS IDENTIFED.

1. Zanthorhiza apiifolia. L'Her.

Vitaceæ.

2. Vitis cordifolia, Michx.
3. Ampelopsis quinquefolia, Michx.

Rhamnaceæ.

4. Ceanothus americanus, L.

Celastraceæ.

6. Celastrus scandens, L.

Leguminosæ.

7. Amorpha fructicosa, L.

8. " canescens, Nutt.

Rosaceæ.

9. Spiræa salicifolia.

Saxifragaceæ.

10. Ribes cynosbati, L.
11. " hirtellum, Michx.
12. " rotundifolium, Michx.
13. " prostratum, L'Her.
14. " floridum, L.
15. " rubrum, L.

Cornaceæ.

16. Cornus canadensis, L.
17. " circinata, L'Her.
18. " sericea, L.
19. " stolonifera, Michx.
20. " alternifolia, L.

Caprifoliaceæ.

21 Symphoricarpus racemosus, Michx.
22. " vulgaris, Michx.
23. Lonicera grata, Ait.
24. " parviflora, Lam.
25. Diervilla trifida, Mœnch.

Ericaceae.

26. Gaylussacia dumosa, Torr & Gray.
27. " resinosa, Torr & Gray.
28. Vaccinium oxycoccus, L.
29. " macrocarpa, Ait.
30. " pennsylvanicum, Lam.
31. Arctostaphylos uva-ursi, Spreng.

This short and imperfect list is given in the [illegible] shall have both time and means to extend the list.

PHÆNOGAMOUS PLANTS [illegible]

[illegible]

1. Anemone patens, L.
2. " parviflora, Michx
3. " cylindrica, Gray
4. " [illegible] L
6. " [illegible]

7. " nemorosa, L.
8. Hepatica triloba, Chaix.
9. Ranunculus rhomboideus, Goldie.
10. " recuurvatus. Poir.
11. " pennsylvanicus, L.
12. " repens, L.
13. " acris, L.
14. Caltha palustris, L.
15. Aquilegia canadensis, L.
16. Delphinium exaltatum, Ait.
17. " azureum, Michx.
18. Actæa spicata, L.
19. " alba, Bigel,

Berberidaceæ.

20. Caulophyllum thalictroides, Michx.

Nymphaceæ.

21. Nymphæa, odorata, Ait.
22. Nuphar advena, Ait.

Sarraceniaceæ.

23. Sarracenia purpurea, L.

Fumariaceæ.

24. Corydalis flavula, Pursh.

Cruciferæ.

25. Nasturtium sinuatum, Nutt.
26. Arabis canadensis. L.
27. " perfoliata, Lam.
28. " drummondi, Gray.
29. Barbarea vulgaris, R. Br.
30. Erysinum cheiranthoides, L.
31. Lepidium intermedium, Gray.

Resedaceæ.

32. Viola rotundifola, Michx.
33. " blanda, Willd.
34. " selkirkii, Pursh.
35. " cucullata, Ait.
36. " pubescens, Ait.
37. " tricolor, L.

Cistaceæ.

38. Helianthemum canadense, Michx.

Hypericaceæ.

39. Hypericum ellipticum, Hook.

Caryophyllaceæ,

40. Silene nivea, D C.
40. Arenaria lateriflora, L.
42. Cerastium nutans, L.
43, " arvense, L.

Portulacaceæ.

44. Portulaca retusa, englm.

Linaceæ.

45. Linum sulcatum, Riddell.

Geraniaceæ.

46. Geranium maculatum, L.
47. " pusillum, L.
48. Impatiens fulva, Nutt.
49. Oxalis violacea, L.
50. " stricta.

Polygalacea.

51. Polygala sanguinea, L.
52. " senega, L.

Leguminosae.

53. Lupinus perenuis, L.
54. Trifolium repens, L.
55. Psoralea argophylla, Pursh.
56. Petalostemon violaceus, Michx.
57. " candidus, Michx.
58. Astragalus caryocarpus, Ker.
59 " canadensis, L.
60. " cooperi, Gray.
61. Desmodium acuminatum, D C.
62. " rotundifolium, D C.
63· " cuspidatum, Torr and Gray.
64. " paniculatum, D C.

65. Vicia americana, Muhl.
66. " caroliniana, Walt.
67. Lathyrus venosus, Muhl.
68. " ochroleucus, Hook.
69. " palustris, L.
70. Apiosa tuberosa,, Mœnch.
71. Phaseolus perennis, Walt.
72. " paucflorus, Benth.
73. Baptisia leucantha, Torr and Gray.

Rosaceae

74. Agrimonia eupatoria, L.
75. Geum strictum, Ait.
76. " rivale, L.
77. G. triflourm, Pursh.
78. Potentilla norvegica, L.
79. " arguta, Pursh.
80. " anserina, L.
81. " tridentata, Ait.
82. Fragaria virgininia Ehrhart.
83. " vesca, L.
84. Rubus, triflorus, Richardson.
85. " strigosus, Michx.
86. " occidentalis, L.
87. " villosus, Ait.
88. " canadensis, L.
89. " hispidus, L.
90. " cuneifolius.
91. Rosa lucida Ehrhart.
92. " blanda, Ait.
93. Parnassia carolina, Michx.
94. Heuchera hispida, Pursh.

Crassulaceae.

95. Penthorum sedoides, L.
96. Tillæa simplex, Nutt.

Hulorageae.

97. Hippuris, ?

Onagraceae.

98. Epilobium angustifolum.
99. Oenothera biennis, L.
100. " fruticosa, L.
101. " riparia, Nutt.
102. " pumila, L.
103. " serrulata, Null.

Lythraceae.

104. Lythrum alatum, Pursh.

Cucurbitaceæ.

105. Echinocystis lobata, Torr and Gray.

Umbelliferæ.

106. Sanicula marilandica, L.
107. Heracleum lanatum, Michx.
108. Archemora rigida, D C.
109. Conioselinum canadense, Torr and Gray.
110. Thaspium barbinode, Nutt.
111. " aureum, Nutt.
112. " trifoliatum.
113. Cicuta maculata, L.
114. Cryptatænia canadensis, D C.

Araliaceæ.

115. Aralia racemosa, L.
116. " nudicaulis, L.
117. " quinquefolia.

Rubiaceæ.

118. Galium asprellum, Michx.
119. " trifidum. L.
120. " boreale, L.
121. Mitchella repens, L.

Compositæ.

122. Liatris elegans, Willd.
123. " squarosa, Willd.
124. " cylindracea, Michx.
125. Eupatorium perpureum, L.
126. " perfoliatum, L.
127. " ageratoides, L.
128. Aster macrophyllus, L.
129. " sericeus, Vent.
129½ " patens, Ait.
130. " simplex.
131. " novæ-belgae.
132. " ptarmicoides, Torr and Gray.
133, Erigeron philadelphicum, L.
134. " strigosum, Muhl.
135. " var integrifolium, Brgel.

135½ Solidago serotina, Ait.
136. Chrysopsis villosa, Nutt.
137. Pluchea fœtida, D C.
138. Heliopsis lævis.
139. Echinacea (?)
140. Rudbeckia hirta, L.
141. Helianthus tracheliifolius, Willd.
142. " doronecoides, Lam.
143. Coreopsis palmata, Nutt.
144. Helenium antunnale, L.
145. Maruta cotula, D C.
146. Achillea millefolium, L.
147. Leucanthemum vulgare, Lam.
148. Tanacetum huronense, Nutt.
149. Artemisia canadensis, Michx.
150. " borealis Pallas.
152. Senecio lobatus Pers.
153. " aureus, L.
154. Circium, two or three species.
155. Krigia virginica, Willd.
156. Cynthia virginica, Don.

Lobeliaceae.

157. Lobelia syphilitica, L.
158. " Kalmii, L.

Campanulaceæ.

159. Campanula rotundifolia, L.
160. Campanula aparinoides Pursh.
161. Gaultheria procumbens, L.
162. Pyrola rotundifolia, L. 2 var.
163. " elliptica, Nutt.
164. " chlorantha, Swartz.
165. Chimaphilla umbellata, Nutt.

Primulaceæ

166. Lysimachia thyrsiflora, L.
167. " stricta, Ait.
168. " ciliata, L.
169. " lanceolata, Walt.
170 " longifolia, Pursh.

Scrophulariaceæ.

171. Verbascum thapsus, L.
172. Linaria vulgaris, Speng.
173. " canadensis, Mill.

174. Scrophularia nodosa, L.
175. Pentstemon pubescens, Solande.
176. " grandiflorus, Fraser.
177.. Mimulus ringens, L.
178. " jamesii, Tow.
179. Micranthenum nuttallii, Nut.
180. Veronica virginica, L.
181. Gerardia aspera, Dongl.
182. " tenuifolia Vahl.
183, " setacea, Walt.
184. Castilleia coccinea, Spreng.
185. " sessiliflora, Pursh.
186. Pedicularis canadensis, L.

Verbenaceæ.

187. Verbena hastata, L.
188. " urticifolia, L.
189. . V. bracteosa, Michx.
190. Phryma leptostachia, L.

Labiatæ.

191. Mentha canadensis, L.
192. Lycopus europæus, L.
193. Hedeoma pulegioides Pers.
194. " hispida Pursh.
195. Monarda fistulosa, L.
196. Lophanthus anisatus, Benth.
197. Brunella vulgaris, L.
198. Scutellaria parvula, Milchx.
199. " galericulata, L.
200. " lateriflora, L.
201. Stachys cordata, Rid.

Boraginaceæ.

202. Lithospermum canescens, Lehm.
203 " longiflorum, Spreng.
204. Cynoglossum morisoni D C.

Polemoniaceæ.

205. Phlox glaberrima, L.
206. " pilosa, L.

Convolvulaceæ.

207. Ipomœa lacunosa, L.
208. " pandurata, Meyer.

Solanaceæ.

209. Physalis grandiflora, Hook.
210. " viscosa, L.

Gentianaceæ.

211. Gentiana crinita, L.
212. " detonsa Fries.
213. " quinqueflora, Lam.
214. " andrewsii Grisb.

Apocynaceae.

215. Apocynum androsæmiflolium, L.
216. " canabinum, L.

Asclepiadaceae.

217. Asclepias cornuti Decains.
218. " purpurascens, L.
219. " variegata, L.
220. " perennis, Walt.
221. " tuberosa, L.
222. Acerates longifolia, Ell.

Nyctaginaceae.

223. Oxybaphus nyctagineous Swet.

Phytolaccaceae.

224. Phytolacca decandra, L.

Chenopodiaceae.

225. Chenopodium album, L.

Polygonaceae.

226. Polygonum persicaria, L.
227. " hydropiper, L.
228. " aviculare, L.
229. " convolvulus, L.
230. " cilinode, Michx.
231. Rumex britanica, L.
232. " vertieellatus, L.
233. " acetosella. L.

Urticaceae.

234. Urtica gracilis, Ait.

235. " dioica.
236. Laportea canadensis Gaud.
237. Humulus lupulus, L.

Araceae.

238. Arisæma triphyllum.
239. Acorus calamus, L.

Typhaceae.

240. Typha latifolia.

Alismaceae.

241. Sagittaria variabilis, Englm.

Orchidaceae.

242. Cypripedium candidum, Muhl.
243. " parviflorum Salest.
244. " spectabile Swartz.

Amaryllidaccae.

245. Hypoxys erecta, L.

Iridaceae.

246. Iris versicolor, L.
247. Sisyrinchium bermudianum, L.

Liliaceae.

248. Trillium grandiflorum Salest.
249. " cernuum, L.
250. Zygadenus glaucus Nutt.
251. Smilacina bifolia Ker.
252. Polygonatum biflorum.
253. " giganteum.
254. Lilium philadelphicum, L.
255. " canadense, L.
256. " superbum, L.
257. Allium tricoccum, ait.
258. " schœnoprasum, L.

Juncaceae.

Three or four species.

Commelynaceae.

259. Tradescantia virginica, L.

Besides the foregoing list of phænogamous plants, I have partly identified about eighty species of others; also collected and numbered fifteen or twenty species of ferns, sixty or seventy of grasses and forty or fifty of sedges, but I am not yet prepared to affirm that the identifications can be relied upon as correct. The limited time and means at my disposal have not permitted a satisfactory study of them. One or two seasons' residence at Itaska lake, and the time wholly devoted to collecting and identifying, would hardly give a satisfactory list of all the different classes, to say nothing of the entomology and ornithology of the region.

Very respectfully,

O. E. GARRISON.

Topography.

The area comprehended in the examination is embraced between townships 130 and 147, inclusive, of ranges 25 to 40, inclusive, west of the 5th meridian, and townships 41 to 58, inclusive, of ranges 22 to 27, inclusive, west of the 4th meridian, or approximately between latitudes 46° and 47° 42 min. north, and longitude 93° 10 min. and 95° 15 min. west from Greenwich, or one hundred and twenty-six by one hundred and eight miles. In this rectangle, covering an area not far from thirteen thousand six hundred square miles, barely one thousand five hundred square miles were visited by me during the two months occupied in the explorations of the past summer, the limited time and means at my disposal not allowing of a more extended and satisfactory examination. However, excepting a strip of about 40 miles wide, on the west side, south of the line between towns 139 and 140, comprising the country of Ottertail lake and river, and that part of the west side north of the line between towns 141 and 142, about 30 miles wide, together with two small areas on the northern and eastern portions represented on the map, viz: the Bigfork river and Bowstring lake, with the three or four townships adjacent, and the Swan river region, there is but a small part of the whole area which I have not visited and taken notes on some time subsequent to the A. D. 1856, either as U. S. deputy surveyor or in exploring for pine land in the interest of lumber dealers.

The district here brought under our notice includes portions of

the great drainage areas, where the chief rivers of the continent find their sources. These are the Mississippi, the Red river of the North, with a main branch of the Rainy Lake river. The first is east and south of the great water shed, whose waters flow into the Gulf of Mexico, while the other two are portions of the widely extended area whose waters are drained into Hudson's bay; while the eastern boundary very nearly follows the divide from which the waters flow east into the St. Louis river and finally into the Atlantic, through the great lakes and the Gulf of St. Lawrence.

The area of the Big fork of the Rainy Lake river is of comparatively limited extent, on the northern part of the rectangle, and near its eastern end. The Red river area is quite regular in outline, though the streams flow in widely different directions, its upper or northern portion is the broadest, its waters draining north and west, while the middle and southern portion drain to the south and west.

Of the great Mississippi area, which takes up more than three-fourths of the rectangle, the waters flow in every conceivable direction. The outline of this area may be roughly stated as a circle with an irregular or crooked circumference, having a radius of fifty miles, taking that part of the Mississippi below the mouth of Crow Wing river, thence to the mouth of the Little Elk, as a section of this radius, protract this line nearly due north, and it will cross Leech lake passing a little to the west of Lake Winnebigosis Bisect this line and from the point thus found, draw a line at right angles both east and west, extend each fifty miles, and we have the two diameters of the circle. The Mississippi river will then be comprehended in this circle with nearly all its feeders above Little Falls; while the channel of the Mississippi with a radius of about forty miles, will form nearly three-fourths of its circumference. Within this great circle are found several smaller circles within which the rivers and brooks converge to a point of outlet. Each small circle contains a *cluster of lakes*, some having a few large lakes, as that one in which is found Leech lake, and the one containing Gull, Pelican and Long lakes; the others have many small lakes. In the rectangle represented on the plate are seen seven large clusters, in all of which the water converges to one outlet, and two large and one smaller cluster from which the waters flow in opposite directions. These last will be found in Gull lake, whose waters drain south, and Pelican Lake whose waters run north, and the cluster northwest of Mille Lacs lake, where the waters drain north and northeast through Mud river and southwest

by the Noaka river. The small cluster is seen to the west of the southern part of Mille Lacs, where the water drains east to that large lake and west by the Platte river. A study of this area gives the impression of one large basin enclosing many smaller ones.

The Divides.

The main divide coming on this sheet, is the one separating the waters of the Mississippi from those of the Red river of the North. Beginning at the northern limits of the State near the line of ranges 36 and 37 of the 5th mer., township 147 N., the trend is a little to the east of south to the head of upper Red lake; thence it bends to the west of south—nearly southwest, but with an irregular line, to a point to the east about two miles from the north end of Many Point lake, whence its course is nearly due south 12 or 15 miles, to near Toad lake, whence it bears off a little to the east. A high hill is visible for many miles, and the divide assumes a broad table-like expanse. From here the divide has a general south trend for twenty or twenty-five miles, and is crossed by the Northern Pacific railroad in the vicinity of New York mills; here it takes a bend to the southwest, and passes between the Leaf lakes and Otter Tail lakes where it is about eighty feet above the surface of the fourth lake of the series in the old route from the Crow Wing river by way of Leaf lakes and river. This hight of land is as mentioned by Prof. D. D. Owen in his narrative. The only place where I have had an opportunity to measure the hight of this line of divide, was where the Leech lake and White Earth road crosses near the southern part of township 141, N. R. 38, W. 5th mer., where I found it to be 1470 feet above the sea and 75 feet above the surface of the water in a small lake south of the road. Within the hills forming the divide is the outlet of the lake flowing to the west into the Otter Tail or Red river. Only small portions of the other main divides come within the limits of this sheet. That part of the northern range of hills that separates Lake Winnebigosis from Bowstring lake and Big Fork river comes within our limits near the northeast corner of town 147 N. range 27 west, 5th mer. and bears nearly southeast, passing a short distance from the Bowstring lake to near the range line between ranges 25 and 26 of town 146, N. 5th mer., where it bends to the east and the *Third guide* meridian crosses it a little north of the northwest corner in township 57, nortn 4th mer., whence it bears a little to the south of east for about six miles

when the trend takes a suddden bend at nearly a right angle and leaves the limits of the map near the middle of the north boundary of town 58, N. R. 25, west of the 4th mer. This portion of the great water shed dividing the waters flowing into Hudson's bay from those flowing into the Gulf of Mexico is said to be low, seldom rising in the form of a ridge, and at the trend near the southeast end of Bowstring lake in a swamp only a foot or two above the surface of the lake. It is also said that by building a dam at a favorable place at the outlet of Bowstring lake, the waters could readily be made to flow to the south into a tributary of the Winnebigosis lake. I am not prepared to affirm this from personal inspection, but Mr. J. P. Hinchellwood, the U. S. deputy who surveyed the townships around the lake so reports. The divide on the east I have not seen, but it is reported to be high and broken, some of the hills on the trail or carry, from the head of West Savanna to the East Savanna river, by barrometer measurement, being over 139 feet above the waters of Sandy lake. In all this region there is no hill approaching to a mountain. The recorded highest point I have seen being only 1960 feet.

Subordimate divides. The area comprised within the circle where streams are all feeders to the Mississippi; may with propriety be described as a large basin within which are many small basins. Most of these subordinate basins have a drainage of their own, and are readily distinguished by the clusters of lakes seen on the maps.

Having never seen any records of the hights of these, and no opportunity to measure any of them save in a few localities having presented, I must perforce content myself by calling attention to this peculiarity in the hopes that some time hereafter an opportunity may occur to study it in the field.

The Streams.

The streams are so numerous that only a few can be noticed here.

The Mississippi. The most important of all, having its source within this district, merits a far more extended notice than I am able to give from the hasty and short time expended in its examination. It takes the name Mississippi only after its debouch from Itasca lake. There are several streams entering the lake which have disputed the right to be the extreme source. The one adopted by Nicollet and in the preceding narrative is the largest feeder to the lake and should have the name. The lake is a little over

three miles long, north and south, shaped some like a letter U with a projection on the northwesterly side of the curve. The widest part is a little over half a mile. To continue the description would only be repeating what has been said in the narrative of the journey down the river.

Crow Wing River. Of the tributaries to the Mississippi, the Crow Wing is the most considerable within the limits of the district. Taking its rise in some of its branches only a few miles south of Itasca lake it pursues a general southeast course, making a southing of about sixty miles and an easting of nearly the same. Its principal feeders are the Shell, the Leaf and the Long Prairie, all of them considerable streams. Throughout its whole course and that of all of its wide spread branches, excepting those coming from the south and entering the Leaf on the Crow Wing itself, the country is of a sandy character, bearing a small growth of pines, the black pine, *Pinus banksiana* being the characteristic tree, with here and there a grove of fair sized Norway pine mixed with which is a few white pines. Yet in this area there are some large and many small tracts where the prevailing light sandy soil gives place to a rich, black sandy or gravelly loam.

Pine River is next in size and first in importance of the tributaries to the Mississippi; taking its rise south of Leech lake and east of a broad stretch of sandy plain, it has a general southeasterly course, making about 25 miles southing and 26 or 27 miles easting from its extreme branches. In nearly its whole length it appears to form the dividing line between the sandy black pine planes and the rolling or hilly country to the east and north, where the surface soil is of a heavier or clayed nature with more boulders and the characteristic tree the white pine. Its principal tributaries are the Dagget brook and the Little Pine, both important streams from which many million feet of pine saw logs are annually floated to the mills of Minneapolis and St. Cloud.

Leech Lake River is apparently larger than the Pine, but I do not think that it carries more water. The channel is deep, broad and sluggish. The general dip or inclination of the surface throughout this whole region being about southeast the course of the river is at nearly a right angle to the dip, giving to the river this sluggish character.

Willow River has its source to the southeast of Leech lake and has a general course easterly for about twenty-four miles when by a long curve it bears to the south, east, south, and then finally southwest for about 28 miles; the whole of this distance nearly par-

allel with the Mississippi a gradually narrowing strip lying between. In the first part of its course the country is hilly or rolling and holds some of the best pine timbered lands within the circle of which the Mississippi forms nearly two-thirds of the periphery; and from its tributaries, the Moose and Hill rivers, as many or more good saw logs have been floated to the mills than from any similar area on the upper Mississippi. Below where the bend towards the south commences the river flows through broad plains with extensive meadows and swamps of cedar; the immediate river bottoms being covered by a growth very similar to the Mississippi bottoms.

These four rivers are the principal tributaries to the Mississippi within the rectangle, and are wholly, with the exception of some of the upper parts of the smaller branches of the Crow Wing, within the circular area of which the Mississippi is the approximate periphery, and enter it from the right bank. Besides these there may be mentioned the Little Willow, and the Pokegama, tributaries direct to the Mississippi; the Shell, the Leaf, the Longprairie, Gull and Swan Rivers, tributaries to the Crow Wing; all important streams carrying much water and floating many pine saw logs each spring.

The *Little Elk*, entering the Mississippi from the right, was noted by Nicollet and Owen on account of the proximity of its mouth to some important geological features, and is an imporrant stream to lumbermen.

The tributaries to the Mississippi coming in on the left bank are generally smaller than those on the right, which is owing to the fact that the great water shed of the continent is more nearly followed in its curves by the Mississippi, as if in the great upheaving which formed the divide, a wrinkle was formed following near the summit through which the Mississippi naturally found its bed. I will mention the names of the largest beginning with the upper. Turtle, Deer, Prairie, Swan, Sandy, Rice, Mud, Rabbit and Anoka. The Platt, Rum and Snake Rivers having their source within the rectangle, are tributaries to the Mississippi, directly or indirectly.

The Red River of the North receives its principal water from within our area. Much perplexity has been occasioned by this branch as well as the Red Lake River, being indiscriminately called the Red River. Owen gives the width of the east branch, by which I suppose he means the Red Lake River, as one hundred and twenty feet and the other as one hundred feet. "The former

is the stream to which the name of Red River properly belongs."* Taking its rise about twelve miles to the west of Itasca Lake, the latter has a general south course, making many detours to the east and west, passing through many lakes and receiving several tributaries in a course of about fifty miles to Rush Lake; thence it flows about southwest to Otter Tail; leaving Otter Tail Lake it has a general north of west course and leaves the district in town 134 N.

Wild Rice River has its rise in township 145 N., R. 36 W., 5th mer., and about twelve miles north of Itasca Lake, whence its course is a little south of west, seventy miles, emptying into Red River in township 144, R. 49. Having seen no part of this river, I am not able to give an account of its character or the country adjoining. A branch of the Red Lake River takes its rise in a small lake in the northwest corner of town 146, R. 39, and has a north course to the north line of our rectangle.

The *Big Fork River* rises to the north of our area and east of the fifth guide meridian, and has a southwest course to Bowstring Lake in township 147 N., R. 25 and 26 W., 5th meridian. I have heretofore at several times referred to this river, and no more information can be given. Owen's report gives a very minute account of this river and its rock exposures.*

The *East Savanna River*, a branch of the St. Louis, rises in a small lake in T. 52 N., R. 22 W., 4th mer., and is described as a stream having a width of one hundred and fifty to two hundred yards, overgrown with rushes, except a channel fifteen or twenty feet wide in the middle. The river has only eight or ten miles length within our area.

Lumbering Resources.

In the estimate of the amount of pine timber suitable for manufacturing, standing at this date, I take it that there is an equivalent to forty townships, on each forty acre tract of which there are 250,000 feet of pine standing. This is taken after a careful examination of all the data I have been able to collect, and if correct, then we shall have 5,760,000,000 feet. This includes about one township out of every nine within our district, all of which are within the area where drainage goes into the Mississippi river. It also includes the several Indian reservations, on which are many millions of feet of excellent pine, and a tract on the Big Fork riv-

*Owen's Geological Survey of Wisconsin, Iowa and Minnesota. 1852, page 176.

er, whose waters are *now* drained into the Rainy Lake river; but it seems from the facts obtained, the two hundred and fifty or three hundred million feet on that stream, Bowstring lake and the tributaries thereto, may be floated down the Mississippi. Many of the Indians and half breeds interested in the various reservations are beginning to realize the fact that in this pine timber on the reservations they have a mine of wealth, and all will be made available to manufacturers.

How long the timber now standing and available will last is a question often asked, and it is a question of interest, not to the rising generation only, but to the present, as in a few years—at most within twenty-five—at the present rate of destruction, with no more effort than is now used to arrest useless waste or to renew the growth, will see an end of lumbering on the upper Mississippi. To demonstrate this will require only a little reflection and a few figures. There was manufactured at and above Minneapolis during the years 1875 to 1879, inclusive, 867,087,685 feet of lumber, being a mean of 173,407,737 feet per year. It is but a fair estimate that there is as much more destroyed by fires, storms, natural decay and useless waste in the forest by careless handling. On the other hand there is an increase by the annual growth of trees now too small for saw logs. From a great many measurements of the growth, I have found that a tree that in, say 1865, measured twelve inches in diameter, in 1879 measured twenty inches in diameter, an increase of eight inches in fourteen years. This may be considered as a fair average of the growth of pine in the upper Mississippi region, and an estimate of 58,000,000 as the annual increase by natural growth. Now if we add the excess of loss by causes above mentioned, amounting to 115,000,000 feet, to the annual consumption, we have a total of over 288,000,000 feet as the annual consumption and loss. Then divide the five hundred and seventy-six millions by the two hundred and eighty-eight millions and it gives an even 20 years as the time within which lumbering will cease to be a profitable business from the pineries on the upper Mississippi, unless some means are provided to prevent the annual consumption and waste.

VIII.

THE HYDROLOGY OF MINNESOTA.

A REPORT OF PROGRESS BY C. M. TERRY.

Any attempt to discuss the hydrographical system of any portion of the earth's surface should begin with the rainfall, because as has been said by a distinguished scientist, the true sources of our rivers is in the air.

The condensation of watery vapor in the atmosphere causes rain and the rain supplies our lakes and streams and springs and wells with all the water they contain.

Every drop of water even in the deepest well once floated as invisible vapor in the sunlit air and falling from thence onto the earth's surface with other drops, it percolated down through the soil, through loam, and sand, and gravel; through rock crevices and subterranean channels, until, at last the necessities of man found it in its prison, and raised once more to the light.

Every particle of water which the Mississippi bears to the sea has come from the clouds.

Every lake which mirrors the sky and reflects its light is like a child looking up into the face of its mother, for no lake could exist but for the clouds and the rain.

The average annual rainfall of a place is therefore a matter of the utmost practical importance. If it should be cut off or materially diminished the most serious consequences would ensue. Rivers would shrink to mere brooks or cease to flow, water powers would become valueless, mills would be idle, crops would fail, and the country would become an uninhabitable desert.

But the 26 inches of water which annually falls over the greater part of Minnesota makes it anything but a desert. A glance at

the hydrographical map shows what a vast and complicated net-work of lakes and rivers is required to carry off even a part of this preciptation.

Few persons stop to consider or attempt to realize the vast amount of water represented by an annual rainfall of 26 inches.

It may help the imagination to obtain a more distinct conception of this fact if I quote right here a few words from a lecture by Prof. Huxley, on Rain and Dew.

"What does a meteorologist mean when he says that the annual rainfall is about 26 inches? By such a statement he means simply that if all the rain which falls on any level peice of ground during an average year could be collected, none being lost by drying up, none running off the soil, and none soaking into it, then at the end of the year it would form a layer covering the ground, to the depth of 26 inches. The year's accumulation of rain would thus form a vastness of water. Remembering that an inch of rain represents about 100 tons of water to the acre, it will be found that every acre receives during the year not less than 2,600 tons of water."

Rainfall at Minneapolis from records of Mr. Wm. Cheney showing the annual deposit of rain for ten years:

Year.	Annual Amount.	Year.	Annual Amount.
1871	30.904	1876	28.749
1872	24.946	1877	25.208
1873	31.902	1878	22.153
1874	29.043	1879	27.180
1875	30.042	1880	

The average annual rainfall for 14 years according to Mr. Cheney's observation is 29.318.

The annual rain-fall of eastern Dakota from data furnished by the war department:

Name of place.	Length of time.	Amount.
Fort Pembina	Average of 8 years	16.91 inches.
Fort Wadsworth	" " 5 "	18.95 "
Fort Abercrombie	" " 17 "	18.44 "
Fort Randall	" " 8 10–12 years	16.51 "
Fort Pierce	" " 1 10–12 years	13.51 "

The Rev. Dr. A. B. Patterson of St. Paul kept a meteorolgical record from 1860 to 1876, the year of his death.

The subjoined table gives the total rainfall for each month during a period of 16 years and also the monthly and annual means:

	Totals.	Monthly mean.		Totals.	Monthly mean.
January	15.17	0.95	September	55.79	3.46
February	17.61	1.10	October	34.63	2.15
March	23.58	1.47	November	22.08	1.31
April	31.04	2.06	December	14.33	0.90
May	56.14	3.51			
June	74.53	4.66	Total		29.08
July	46.47	2.90			
August	73.23	4.57			

The average annual rainfall is 29.08 inches.

Annual and monthly means of rainfall in Dakota from data of the War Department up to 1878.

MONTH.	Fort Abercrombie 1860 to 1877	Fort Pembina. 1871 to 1878	Totals.	Grand Mean.
January	0.52	0.18	0.70	0.35
February	0.55	0.34	0.89	0.44
March	1.01	0.70	1.71	0.85
April	1.54	1.17	2.71	1.35
May	2.16	2.65	4.81	2.40
June	3.20	3.91	7.15	3.51
July	2.23	2.81	5.04	2.52
August	2.63	2.64	5.27	2.63
September	1.66	1.24	2.90	1.45
October	0.96	1.24	2.20	1.10
November	0.64	0.52	1.01	0.50
December	0.70	0.77	1.51	0.75
Mean	18.44	16.91	35.25	17.67

Annual and monthly means of rain fall in Minnesota from data furnished by the War Department up to 1878.

MONTH.	Fort Snelling 1836 to 1878.	Fort Ripley 1849 to 1877.	Fort Ridgely 1855 to 1867.	St. Paul, 1859 to 1866. 1871 to 1878.	Grand Mean.
January	0.97	0.85	1.51	0.88	1.07
February	0.76	0.92	1.36	0.97	1.00
March	1.31	1.55	1.61	1.78	1.56
April	2.13	1.62	1.60	2.20	1.89
May	3.40	3.08	2.88	3.75	3.28
June	3.80	4.33	2.59	5.82	4.13
July	3.01	4.14	2.67	2.68	3.07
August.........	3.24	3.11	4.02	3.96	3.58
September	3.42	3.28	3.22	3.09	3.25
October	1.39	1.60	1.65	2.08	1.68
November	1.49	1.73	1.18	1.17	1.39
December	0.94	0.91	1.12	0.72	0.92
Mean	25.89	27.31	25.31	25.09 29.05	26.41

The River System.

All of the southern and central portions and a large area of the northern part of Minnesota are drained by the Mississippi river and its tributaries.

In the northwestern part of the State the Red river valley which is drained by the Red river and its affluents comprises in Minnenesota an area of over 13,176 square miles.

The drainage is toward the north. The Red River flows into Lake Winnipeg, the outlet of which is the Nelson river, which finds the ocean through Hudson's bay.

All of the most northern streams tributary to the Rainy Lake river and the system of lakes on the boundary line between the United States and Canada belong also to the Red river system and finds the ocean level at Hudson's Bay.

This portion of the State has not yet been fully surveyed and the courses of the streams as well as the size and shape of the lakes are not accurately laid down on the maps.

In the northeastern part of the State a large area estimated at about 9,000 square miles is drained by tributaries of Lake Superior. The principal river of this region is the St. Louis, which enters the Lake at Duluth.

As Lake Superior in common with other great lakes finds its outlet to the sea through the river St. Lawrence, the whole vast system of lakes and rivers affluent to the St. Lawrence have received the the name of the St. Lawrence system.

The area drained by the Mississippi and its branches comprises all the remaining portion of the State except a small tract in the southwestern corner including Rock and Pipestone countres whose streams flow into the Missouri. But as these in common with the Mississippi waters find the ocean level in the Gulf of Mexico they may be considered in the same hydrographic basin. Thus it appears that the river system in our State is threefold: 1. The Mississippi river system. 2. The St. Lawrence river system. 3. The Red river and Rainy Lake system.

Among the great rivers of the world the Mississippi takes the first rank. Its position and offices are continental as those of no other river are.

Its branches stretch from the forty-ninth parallel of latitude —the northern boundary of the United States—to the Gulf of Mexico and from the summit and crown of the Rocky Mountains, in northern Montana to the western slope of the Appalachian range in Virginia. This magnificent basin is the seat of an empire whose resources have only begun to be developed. About midway between the eastern aud western limits of this great valley are the sources of the mighty river whose arms grasp the continent. Among the clear, bright lakes of Minnesota, on the highest lands between the Arctic ocean and the Gulf of Mexico, the Mississippi begins its course.

Within the limits of our State the Mississippi grows from a rill sixten feet wide and fouteen inches deep, to a great river, half a mile wide and from 5 to 20 feet deep. It assumes within our borders its well-known character of the "Father of waters."

Let us now proceed to Lake Itasca and observe the physical aspects of the river as it appears to a voyager who descends its current from its ultimate source to the point where it passes beyond the southern boundary of our State.

When we consider the influence the Mississippi had, not only on the imagination of early explorers but also at a later date on the development of the cities and States adjacent, we cannot wonder at the enthusiasm evinced to discover and describe its utmost source and to explore the impenetrable and trackless wilderness which shrouded in its mysterious silence the origin of the great river. It was the same sort of enthusiasm which has prompted so may expeditions in search of the sources of the Nile. The discovery of the source of the Mississippi, although attended by some difficulties and hardships, was a comparatively easy task.

The first white man who is known to have visited Lake Itasca

was W. Morrisson, an Indian trader and explorer. He first saw the lake in 1804.

In 1820 Mr. H. R. Schoolcraft made a memoriable expedition to the head waters of the Mississippi and proceeded as far as Cass Lake which he named for Lewis Cass then Governor of Michigan. From this point Schoolcraft turned back, but in 1832 in a second journey he pushed on to Lake Itasca and camped on the little Island in the lake which bears his name.

The next visitor who has left any public record of his expedition was Nicollet the French scientist whose name is a household word in Minnesota, since a county, a township, a lake, a railroad station, a hotel, a street in Minneapolis and an island are named for him.

Nicollet explored Lake Itasca in 1836. His description is so vigorous and charming that I transcribe a portion of it:

"The Mississippi holds its own from its very origin; for it is not necessary to suppose as has been done, that Lake Itasca may be supplied with invisible sources to justify the character of a remarkable stream which it assumes at its issue from this lake.

There are five creeks that fall into it, formed by innumerable streamlets oozing from the clay-beds at the bases of the hills that consist of an accumulation of sand gravel and clay intermixed with erratic fragments; being a more prominent portion of the great erratic deposit previously described, and which here is known by the name of "Hautes des Terres" heights of land. Now of the five creeks that empty into Itasca Lake, one empties into the east bay of the lake, the four others into the west bay. I visited the whole of them; and among the latter there is one remarkable above the others inasmuch as its course is longer, and its waters more abundant: so that in obedience to the geographical rule "that the sources of a river are those which are most distant from its mouth" this creek is truly the infant Mississippi, all others below its feeders and tributaries.

"The day on which I explored this principal creek (August 29, 1836) I judged that at its entrance into Itasca Lake its bed was 15 to 20 feet wide and the depth of water from 2 to 3 feet. We stemmed its pretty brisk current during ten or twenty minutes, but the obstructions occasioned by the fall of trees compelled us to abandon the canoe and seek its springs on foot along the hills. After a walk of three miles during which we took care not to lose sight of the Mississippi my guides informed me that it was better to descend into the trough of the valley; when, accordingly, we

found numberless streamlets oozing from the basis of the hills The temperature obtained at a great number of places by the thermometer in the mud whence these springs arose, was always between 43° 5 min. and 44° 2 min. Fah., that of the air being between 63° and 70 .

Having taken great pains in determining the temperature, I have a right to believe that it represents pretty accurately the mean annual temperatures of the country under examination.

As a further description of these head-waters I may add that they unite at a small distance from the hills whence they originate and form a small lake from which the Mississippi flows with a breadth of a foot and a half and a depth of one foot. At no great distance, however, this outlet nniting itself with other streamlets coming from other directions supplies ;a second minor lake, the waters of which have already acquired a temperature of 48° Fah. From this lake issues a rivulet necessarily increases importance—a cradles Hercules giving promise of the strength of his maturity, for its velocity has increased; it transport the smaller branches of trees; it begins to form sand-bars; its bends are more decided until it subsides again into the basin of a third lake somewhat larger than the two preceding. Having here acquired renewed vigor and tried its consequence upon an additional length of two or three miles it finally empties into Itasca Lake, which is the principal reservoir of all the sources to which it owes all its subsequent majesty."

Lake Itasca.

The lake which is the acknowledged source of the Mississippi river, is in no way remarkble. Not unlike some historical movements, whose beginnings are obscure, this river which becomes a marked feature of the continent, has a humble origin.

Itasca lake lies on the northeast corner of T. 143, N. range 36, W. 5th meridian.

It is quite small. Its total length does not exceed five miles. It is from a quarter to half a mile wide. The lake consists of two arms of unequal length uniting in a third arm which, however, is no larger or longer than the others. The longest arm extends to the southeast about two and a half miles. The shorter arm extends to the southwest and is about a mile long. The third arm extends north from the point where the two arms already mentioned unite, and is about two miles long.

The inlets of the lake are on the shorter or southwest arm. There are five of them. They are small streams draining the swamps and springs in the vicinity. Less than a quarter of a mile south of the southwest arm is a little lake called Elk lake. It has an area of about 200 acres. It is a mile long and half a mile wide. It is a tributary of Itasca lake through a small creek which connects them. Elk lake has two or three small streams flowing into it from the south. The principal stream tributary to Itasca lake directly, also flows from the south and is three or four miles in length. It is rather a refinement of exactness to call Elk lake, as some explorers have, the ultimate source of the Mississippi. Itasca lake has been in possession of the honor so long, that its claim ought not to be disputed, and certainly it is sufficiently minute, remote and sylvan to answer all the requirements of an ideal "source." The area of Itasca lake is about 1125 acres, or not quite two square miles of water. Its depth varies from ten to twenty-five feet.

The temperature of the water in August was 62° Fah., at the same time the air was 56° Fah. In July Mr. Siegfried found water 74° Fah., air 76 F. There are probably no springs in the lake itself. The water, however, is clear and wholesome. A dense forest of mixed hardwood and pine trees surrounds the lake. The immediate shores are not high, although back a short distance the sand ridges and hills rise in some places 120 feet from the lake. Issuing from Lake Itasca in a stream 14 inches deep and 16 feet wide, the infant Mississippi flows nearly due north for twenty or twenty-five miles. Its banks are low, and for some distance on either side adjacent lands are swamps. Fallen trees and floodwood at first somewhat obstruct the channel. There are several small tributaries in the first fifty miles, and the river gradually becomes broader and deeper.

About twenty-five miles (fourteen miles in a straight line) north of Lake Itasca, the river makes a bend to the east and continues to flow in a general easterly course as far as the outlet of Lake Winnebigosis, a distance of fifty-four miles in a straight line and nearly twice as far by water.

Lake Pemidji or "Lac Travers."

Just before entering Lake Pemidji the river passes through a small lake, the first on its course, named Lake Marquette. Pemidji, or "Lac Travers" of the early fur traders, is a beautiful

large sheet of water about seven miles long by two or three miles wide. Its waters are clear and pure. It has no islands. Its depths range from 12 to 40 feet.

On issuing from Lake Pemidji the river is 150 feet wide and it continues to maintain a breadth of 110 to 150 feet till it reaches Lake Cass. Its depth varies from two to six fee. For the first 15 or 20 miles below Lake Pemidji the river flows over numerous granitic boulders causing rapids. The current is quite swift and strong.

Cass Lake.

The river enters Cass Lake on the west side about midway between its northern and southern limits. The lake is a large one and has many bays and islands. It covers an area of about 31 6-10 square miles. It is longest from north to south. Including Pike Bay its length is not less than twelve miles.

The surrounding country is a forest of elm, maple and pine.

This was the furthest point reached by Mr. Schoolcraft in the expedition of 1810. The lake was then named Lake "Cassina" and it was regarded for a time as the source of the Mississippi.

The river where it leaves Cass Lake in township 146, range 30, has a width of 172 feet and is 8 feet deep. Its banks are 10 to 12 feet high. Between Cass Lake and Lake Winnebigoshish the river has a narrow flood plain. A short distance back from the water there is a bench of higher land supporting a fine growth of pines. The distance between these two lakes in a direct line is only ten miles. Following the course of the river it is about 20 miles. The most attractive country near the head waters of the Mississippi is between and around these lakes.

Lake Winnebigoshish.

This lake—the second in size in this region—has an area of seventy-eight and a half square miles. It is eight miles wide by about twelve miles long from north to south. The river enters on the southwestern side and leaves it at the northeast corner.

Unlike most of the lakes in this part of the State, the waters of Winnebigoshish are not clear and translucent. The Indian name, it is said, signifies "turbid water". For some distance out from the shores the lake is very shallow and this fact taken in connection with the clay bottom accounts for the yellowish white aspect of the water. The stiff blue clay called "till" underlies, at the

depth of a few feet, the sand and other superficial deposits which cover the surface of the country. Aside from the Mississippi it has three inlets called Turtle river, Round Lake river and Thornberry river. By natives and traders in the vicinity, this lake is called Winnepeg. On leaving Lake Winnebigoshish the river bends to the southwest. After passing through a small lake called Little Winnebigoshish the river is very tortuous; the banks are low and marshy. The distance from Lake Winnebigoshish to Pokegama Falls is about 65 miles. About 20 miles below the lake the Leech Lake river enters from the west. The river continues to wind through a vast marsh where there is a dense growth of grass, reeds and wild rice. This marsh is about three miles wide beyond which are sandy ridges with a sparing growth of pines. The current of the river is sluggish. The fall from Winnebigoshish to Pokegama falls is but 23 feet. This whole country above Pokegama falls is a great watery plateau, lakes abound in every direction. The difference in level is very slight. Immense swamps adjoin these lakes and retain the rainfall so that sudden rise and fall in the lakes and streams is impossible.

Leech Lake and Leech Lake River.

The principal tributary to the Mississippi above Pokegama falls is the Leech Lake river, which is the outlet of Leech Lake. It is 35 miles long. It is situated in the northern part of Cass county. Its northern limit is only five or six miles south of Lake Winnebigoshish. It drains a large extent of country; four large streams and eight smaller ones flow into it; the water is pure and wholesome; its greatest depths are in the southwest bay, varying from 50 to 100 feet. The bays generally are shallow, varying from 6 to 10 feet in depth. The main body of the lake is from 10 to 13 feet deep. The extreme range between high and low water is 1.7 feet.

The western and southern shores are high and bold. On the northern side there are more marshes and the shores are lower. Evidences of a former higher stage of water are abundant. The old shore line incloses marshes which, owing to the growth and decay of wild rice, rushes and other acquatic plants are constantly encroaching on the lake and diminishing the area of water. Along the bold shores, and all points where the action of ice and waves has not been impeded, there are walls of bowlders, These are mainly crystallized rocks, either granite or gneiss.

Forest Trees.

The forest about Leech lake consists chiefly of pine. The species *Pinus strobus*, white pine, and *P. resinosa*, Red or Norway pine, predominate. The balsam fir, *Abies balsamea*, the tamarack *Larix Americana*, the white cedar, *Thuja occidentalis*, occupy the swamp and low lands. The birch, poplar and maple among deciduous trees are found in places on the uplands among the pines.

Leech lake has three or four islands. The largest is Bear island and is about three miles long. There is a great variety of shore. There are deep bays, and long wooded points, producing a picturesque intermingling of land and water. (Leech lake might be raised two feet without injury to any adjacent shore.)

Pokegama Falls.

From the mouth of Leech Lake river to Pokegama Falls, a distance of 45 miles, the Mississippi continues to wind through a great morass. The current is slow, owing to the tortuous course of the river and the very slight slope; the fall is only 13⅝ feet in the 45 miles. At Pokegama Falls the river plunges over the first exposure of rock seen in descending its course. It is a quartzyte or metamorphic sandstone formation bearing N. E. and S. W. There is no perpendicular fall of the river here, but through a narrow chute the river rushes with great velocity, falling 14 feet in a distance of 880 feet. The altitude of Pokegama falls—head of falls—above the sea is 1266.71 feet.

The exposure of quartzyte seen at Pokegama falls is more finely displayed on the Prairie river, a tributary which enters the Mississippi from the east, two or three miles below the falls.

Below Pokegama falls are the Grand Rapids. There is no rock in place here, but the channel is obstructed by bowlders, over which the water rushes, falling five feet in a distance of 1750 feet. Grand Rapids is the head of navigation on the upper Mississippi.

A notable change in the aspect of the river and the adjacent country occurs below the falls. Some outlines of a valley appear; there are bottom lands covered with elm, ash, birch, basswood and spruce trees, while beyond are higher ridges and levels on which the pine finds a congenial habitat.

The banks of the river are generally higher than above the falls, and the slope averages six inches to the mile as far down as the mouth of the Mud river, near Aitken, on N. P. R. R. The river

is very crooked, but its general direction below the falls is first southeast, then south and southwest to Aitken. It is 150 miles by river from the falls to Aitken. The area of the water-shed of the river in this distance is 2,500 sq. miles.

The principal tributaries between Pokegama falls and Aitken are:

On the east bank, in descending order: Prairie, Wild Swan, Sandy Lake, Rice and Mud rivers.

On the west side are: Split-Hand? and Willow.

A brief notice of these rivers is all that can be allowed in this chapter.

Prairie River.

The Prairie river has its sources in the innumerable small lakes and marshes north of Pokegama Falls. It has a swift, strong current, and in time of high water brings down a large volume to swell the Mississippi, which it enters about three miles below Pokegama falls.

The Wild Swan River.

The Swan river rises in Swan Lake or rather in the tributaries of that lake, and flowing in a southerly direction parallel with the Mississippi for 25 or 30 miles, finally bends to the west near its mouth and enters the Mississippi about midway between Grand Rapids and the outlet of Sandy lake, in Tp. 52, R. 13.

Sandy Lake River.

Sandy Lake river is the outlet of Sandy lake, 86 miles below Grand rapids. The lake has several important affluents. The Sandy river flows into the lake from the south. The N. P. R. R. passes on its head-waters between Kimberly and Island lake stations. In the early history of the northwest this lake had considerable celebrity as a trading post.

Rice River.

Rice river rises in Rice Lake, and the watershed east of Mille-Lac which divides the waters flowing into St. Crois from those of the Mississippi. It enters the river north of Aitken.

Mud River.

The Mud River has its head-waters in the region near the northern end of Mille Lac. Its general course is north.

Willow River.

Willow River is the largest of these affluents. Its sources are southwest of Pokegama Falls. It drains a large territory covered with a dense growth of pines. Its general course is south and parallel with the Mississippi which it enters about 125 miles below Grand Rapids.

In connection with this description of the physical features of the upper Mississippi, some account of the proposed "reservoir system" seems appropriate.

According to the "Report of the Chief of Engineers" for 1879 it is proposed to construct drains for the purpose of restraining and storing the waters of the Mississippi at the following named points: outlet of Lake Winnebigoshish; outlet of Leech Lake; Mississippi river below Vermillion river; Mississippi river at the head of Pokegama Falls.

In addition to these dams are proposed on Pine river and at Gull Lake. In estimating the effect of the reservoirs on the river the last two are not taken into account.

The area and storage capacity of the four reservoirs above Pokegama Falls is stated as follows:

1. The dam at the outlet of Lake Winnebigoshish is to be 14 feet high and 1,114 feet long. This would pond the water up through the Mississippi river into Cass Lake.

Reservoir capacity, 45,754,204,380 cu. ft.

Area of reservoir surface, 4, 312,701,360 sq. ft.

Aree of the basin of supply, 527,459,328,800 sq. ft.

2, The dam at the outlet of Leech Lake is to be 4 feet high and 3,300 feet long.

Reservoir capacity, 22,567,564,800 cu. ft.

Area of reservoir surface, 6,091,430,400 sq. ft.

Area of basin of supply, 27,906,278,400 sq. ft.

3. The dam on Leech Lake River below Mud Lake is to be 6 feet high and 1000 feet long,

Reservoir capacity, 2,885,414,400 cu. ft.

Area of reservoir surface, 480,902,400 sq. ft,

Area of basin of supply, 4,460,544,000 sq. ft.

4. The dam on the Mississippi river below the mouth of the Vermillion river is to be 10 feet high and 2,300 feet long.

Reservoir capacity, 5,770,823,800 cu. ft.

Area of reservoir surface, 961,804,800 sq. ft.

Area of supply basin, 12,071,346,800 sq. ft.

5. The dam at Pokegama Falls is to be 7 feet high and 400 feet long.

The total available supply of water from these five reservoirs is computed in round numbers to be 70,000,000,000 cubic feet. This would furnish for a period of 120 days, between the first of July and the first of November, a supply of 6,750 cubic feet per second, in the river below the falls. The low water flow at St. Paul, where a continuous record of gauge-readings has been kept since 1872, is 5,800 cubic feet per second. In October 1878 the measured discharge at St. Paul was 6,150 cubic feet per second. Adding the reservoir supply to the low water discharge, we get as a result a steady flow of 12 to 13,000 cubic feet per second, past St. Paul during the low water season between July and November.

It is proposed to shut off the entire Mississippi between December first and July first and store the low water discharge as well as rainfall during that period. It is believed that early spring navigation between Aitken and Grand Rapids would not be injuriously affected by this retention of the water above Pokegama Falls, inasmuch as the area of the Mississippi basin between Pokegama and Aitken is 2,500 square miles, and there are several important affluents, already described in this distance. It is thought therefore that previous to July first the Mississippi below Pokegama will have sufficient water for navigation without the flow that naturally comes over the falls.

The data for computing the amount of surplus water in the reservoirs on the first of July, may require modification. It is assumed that the mean annual rainfall for the upper Mississippi basin is 25 inches and that about one-third of this, or 0.7 ft., finds its way into the streams and rivers. The amount lost by evaporation is at present unknown. The amount which will be absorbed by the overflowed lands can only be determined by experiment.

Notwithstanding these and other obscure and doubtful elements in the problem, it appears reasonable that a sufficient amount of water can be stored to give the Mississippi at St. Paul a steady flow during the dry season of 10 to 13,000 cubic feet per second. This would be a great gain both to commerce and manufactures in our state.

Pine River.

The only other important affluent of the Mississippi above Brainerd is the Pine river which forms the outlet of a chain of lakes of which Whitefish and Cross lakes are the largest. Pine river drains an area of about 600 sq. miles. Its general direction is east and south; it enters the river about midway between Aitken and Brainerd. The general course of the Mississippi between these points is west. The pine river, therefore, enters from the north. It is a rapid stream. Its measured low water volume was 782 cu. ft. per second.

In this stretch of the river there three notable rapids.

1. Big Eddy Rapids, where the fall is 5.15 ft. per mile for half a mile.

2. Island Rapids, which are 3000 feet long and the slope 4.62 ft. per mile for the first 800 feet.

3. French Rapids, about 400 feet long and the slope averages about 6 ft. per mile.

Some conception of the volume of the river in this upper rigion may be derived from noting the discharge in cubic feet per second at various points of observation on the river. The following table is from report of chief of engineers U. S. A., 1879.

DISCHARGE OF THE MISSISSIPPI RIVER.

DATE.	STATION.	Height above low water.	Discharge in cubic feet per second.
1874.			
Sept. 8	Above Cass Lake	Mean H. W.	517
Aug. 22	Below Cass Lake	1.855	891
Sept. 26	Below junction of Leach Lake River	3.931	1,958
Oct. 12	Above Pokegama Falls	2.569	2,474
Oct. 15	Below Grand Rapids	Mean H. W.	2,525
Oct. 20	Below Swan River	Mean H. W.	2,969
Oct. 27	Below Sand Lake Riλer	Mean H. W.	2,946
Nov. 3	Below Willow River	Mean H. W.	3,784
1878.			
Oct. 14	Below Lake Winnebigoshish	Mean L. W.	541
Oct. 21	Below junction Leach Lake River	Mean L. W,	909
1875.			
May 26	Brainerd	8.50	13,084
May 31	Brainerd	8.46	13,082
June 3	Brainerd	9.05	13,444
1875.			
May 13	Sauk Rapids	6.36	22,084
May 15	Sauk Rapids	6.24	22,700
May 20	Sauk Rapids	6.17	21,199
June 7	Sauk Rapids	8.00	30,936
June 15	Sauk Rapids	6.50	34,668
Jusy 16	Sauk Rapids	2.38	8,336
July 19	Sauk Rapids	2.15	7,537

The Minnesota River.

A small stream about twenty feet wide and from one to two feet deep, enters Brown's Valley one mile below Lake Traverse from the northwest, and after making several bends, empties its waters into Big Stone Lake. This stream is the Minnesota river at its beginning. It drains the uplands that stretch away to the conteau northwestward from Big Stone Lake. It has several affluents, and drains an area of 310 square miles.

Brown's Valley is about five miles long, and from one two miles wide. The valley is nearly level and is elevated, in general, from 15 to 20 feet above the lakes on either side. Its soil, gravel-ridges and sloughs give evidence that it was once the bed of a great river. At present it is dry. except times of very high water, when the infant Minnesota overflows its banks, and the lakes are raised to the highwater level. In these circumstances the sloughs and marshes are filled, and there is a water connection through them between Lac Travers and Big Stone.

This connection is, however, only temporary and incidental. The outlet of Lac Traverse is through the Bois de Sioux into the Red River of the North. The elevation above the sea is 1000 feet. while that of Big Stone is 992, making a difference of 8 feet. But the filling up of Brown's Valley with alluvium and silt of the old river has constituted here a "divide" or water-parting, so that Lac Travers has become a part of the Hudson's Bay system, while Big Stone remains loyal to the Mississippi.

Big Stone Lake (Inyan Tonka) is so named on account of the exposure of granite about one and a half miles below the outlet of the lake, where the rock outcrops in large round and glaciated masses, which rise, in some instances, from 40 to 60 feet above the river. The lake is about 26 miles long, and from a mile to a mile and a half wide. Its greatest depth is abovt 30 feet. Its basin is the trough excavated by a glacial river which formerly drained the Red River valley. Gen. Warren and others have suggested that the silting up of the valley just below the lake, at the mouth of the Whetstone, by the sediment brought down by that tributary may account for the existence of Big Stone Lake.

The bluffs which enclose the whole valley on both sides are here from 125 to 150 feet high. The descent is gradual at some points, abrupt at others; or they rise from the lake shore almost perpendicular to it, for 40 or 50 feet, and then slope away to the summit, The shores are wooded, and walled with boulders. There are sev-

eral small streams entering the lake through deep ravines. At the lower end are several wooded islands; the largest (Chamberline's) contains about 125 acres. Another, called "Paradise Island" contains about 70 acres. Ortonville and Big Stone City are situated at the foot of the lake. At the outlet of the lake, the Minnesota is about 20 feet wide and flows through a marsh which extends between the bluffs for a distance of two miles.

The general course of the river is southeast, until at Mankato it bends to the northeast and continues in that course till it reaches its junction with the Mississippi at Fort Snelling. The first tributary to the Minnesota below the lake is the Whetstone (Izuzu) which enters the valley through a deep ravine on the west or right-hand side. It has its sources near the Dakota Coteau and is about 25 feet wide at its mouth. In low water its depth is 2 to 3 feet rising, in freshets, to 8 and 10 feet. Its area of watershed is 110 sq. mi. Below the Whetstone the valley is about a mile and a half wide while the river is less than 50 feet wide. Ledges of granite and granite boulders are numerous in the hollow lands.

The Yellow Earth River (*Mankareoza*)

is sometimes called the Yellow Bank. The Indians also called it *Chra Wakon* spirit mound on account of a hill near its source. At its confluence with the Minnesota it is about 25 feet wide. It has its source near the coteau and its course is among gravelly hills and ridged in the western townships of Lac qui Parle county. Its waters comprises about 340 square miles.

Proceeding down the river some three or four miles below the Yellow Earth, we come to a broad marsh about one mile wide and four miles long. The valley of the Minnesota at this point is 3½ miles wide, whilethe river is from 50 to 60 feet wide.

The Pomme de Terre (*Tipsina*)

river has its sources in Turtle Lakes, Wall lakes and Eagle lake in Otter Tail county.

Its course is almost directly south and it drains an area of about 1000 square miles. It enters the Minnesota valley on the left through a deep ravine, and has brought into it a vast amount of sediment, which has probably caused the existence of the marshy lake before described, above its mouth. At its confluence with the Minnesota the Pomme de Terre is 35 feet wide. At this point

twenty miles below the outlet of the lake the Minnesota has a volume of 42 cubic feet per second in low water.

Lac qui Parle, or the Lake that Talks.

The name is said to be a translation of a Dakota word, signifying echoes. Others hold that the name was given by French traders on account of the resounding of waves on a rocky point of the shore.

The lake is an expansion of the Minnesota River, caused by the barrier of sand and silt which has been brought into the valley by the Lac qui Parle River. It is eight miles long. Its width varies from one-half to three-fourths of a mile. Its greatest depth is about 12 feet. At the upper end of the lake are extensive marshes and there is considerable low, wet land about the lake, which is flooded in seasons of high water. Granite exposures occur on the south side and near the foot of the lake there is a low outcrop on both sides which is submerged except during the dry season.

Lac qui Parle (Intpah) River.

It is said that the Indians gave this river the name *Cha Intpah*, signifying the last wooded stream. It is the last in ascending the river which had timber on its banks in any considerable amount. The river enters the Minnesota Valley on the right bank just below the foot of the lake.

The *Lac qui Parle River* is an important affluent. It drains an area of 830 square miles in Lac qui Parle and the western part of Yellow Medicine counties. Its sources are among the hills and ridges on the western boundary of the State in Canby and Lincoln counties.

Its general course is north and northeast. Its valley varies from an eighth to a fourth of a mile wide, and it has a fall of six to eight feet per mile. In the season of high water it pours a large quantity of gravel and silt into the Minnesota which has probably occasioned the existence of the lake by filling up the valley and thus causing a barrier opposite the mouth of the Lac qui Parle River. The valley of the Minnesota is only one and a half miles wide, and there is an island dividing the ancient channel. The Minnesota flows through the right channel; the Chippewa comes into the left channel and joins the Minnesota at the foot of the island 12 miles below the lake.

The Chippewa River

has its headwaters in the small lakes in the northern part of Douglas county. The sources of the Chippewa are 80 miles in a direct line from its mouth. It drains an area of 2,000 square miles, comprising some of the most fertile and prodnctive lands in the state. Its watershed includes the western part of Douglas, all of Pope and a large share of Swift and Chippewa counties.

Two branches unite near Benson to form the main river. The west branch is the larger and has its source in the north part of Douglas county. The east branch has its sources in the eastern part of Pope county. The country drained by these branches is rolling and hilly. It is the morainic deposit described elsewhere. The river descends more than 400 feet from its source to its confluence with the Minnesota. In the western part of Douglas county, St. P., M. & M. R. R. crossing, the elevation of the river is 1339 feet above the sea. At Benson the elevation is 1021 feet. At its junction with the Minnesota 939 feet, showing a fall of 400 feet.

The valley of the Chippewa, like that of the Minnesota, appears to have been the course along which a glacial river, issuing from the retreating ice-fields, poured its floods of water. The valley is often from a fourth of a mile to a mile wide, and could not have been eroded by the river as it now is.

Ten miles below the Chippewa the Minnesota valley become much narrower. The river itself is about 100 feet wide and there are numerous outcrops of granite, a succession of reefs over which the water flows with rapid current. This is one of the most interesting points in the valley. The granite masses rise from 30 to 75 feet in height and are a picturesque relief to the eye. The head of the rapids is in T. 116, R. 30, sec. 20. The distance from this point to the foot of Minnesota Falls is 5.38 miles and the total fall in the distance is 49.78 feet. Here are located the thriving towns of Granite Falls and Minnesota Falls with their valuable water-powers. The river makes several sharp bends within the valley, but the general southeast course remains unaltered.

The Yellow Medicine

Enters the Minnesota 20 miles below the Chippewa. Its sourçes are among the hills and basins of Lincoln county. It drains parts

of Lincoln, Lyon and Yellow Medicine, an area altogether of 650 square miles. Its general course is north of east.

At the junction of the Yellow Medicine and Minnesota on the bluffs overlooking the valley, was located the upper Sioux agency, famous in the earlier history of the state, and the scene of a terrible tragedy in the Indian outbreak in 1862.

The volume of water in this river is variable. The high water marks indicate that it rises 10 or 12 feet above its low water level.

Hawk Creek (*Chetomba*).

Half a mile below the mouth of the Yellow Medicine Hawk Creek enters the Minnesota from the north. Its sources are in the southwestern part of Kandiyohi and it drains also parts of Chippewa and Renville counties, an area of about 470 square miles. It has eroded a deep channel through the bluffs.

From the foot of Minnesota falls to the mouth of the Yellow Medicine river, the distance is about 4½ miles, and to the mouth of the Redwood it is 25 miles. There are two sets of rapids where ledges of gneiss occur. The first is called Patterson's rapids, and four miles below these are Brown's rapids. The average slope of the river along this part of its course is a little over 2 feet to the mile. Several small streams from the river below Hawk creek, Rice creek, Boiling Springs creek and Sacred Heart creek. The high water mark of the Minnesota above the Redwood is 24 feet above the low water level. The measured discharge of the river in low water, was 217 cu. ft., per second.

The Redwood River.

The Redwood has its sources in the western part of Lyon county, in the same hilly region from which the Cottonwood and Yellow Medicine descend. Its general course is east, and parallel with the rivers first named. It drains an area of 770 square miles, lying in Lyon and Redwood counties.

The gorge at Redwood Falls is two miles long. The river has worn its way down into the granite, and falls a hundred feet in half a mile. The total fall from the top of Cook's milldam to the Minnesota river is 125 feet. The water powers here are valuable, and the place is unsurpassed by anything in the State for its wild and picturesque beauty.

Beaver Creek

Enters the Minnesota three miles below the Redwood, from the north. It is 30 feet wide at its mouth. It drains an area of 240 square miles in Renville county. From the Redwood to the Big Cottonwood the distance is about 40 miles, and the fall of the river 35.75 feet.

The river averages 150 feet in width, while the valley varies from a mile to a mile and a half wide. The low water discharge of the river at Ft. Ridgely which is situated about half way between the affluents above named, was found to be 253 cubic feet per second, and just above the Cottonwood, 307 cu. ft. per second. As the granites and gneisses of this valley are described and classified in another chapter, no attempt is made to recount their appearance, and characteristics here, although they constantly form a very striking and picturesque feature of the scenery. The last exposures of these rocks seen in descending the river, is about four miles below Ft. Ridgley.

The Cottonwood River. (Waraju)

Its numerous sources are chiefly in Lyon county. Its general course is east. It drains an area of 980 square miles in Lyon, Redwood, Brown and Cottonwood counties. Its confluence with the Minnesota is three mile below New Ulm, where it is 120 feet wide. The volume of water varies with the season. In times of freshet it rises 10 feet or more above low-water, and pours a rapid flood into the main river.

The Blue Earth River,

is the largest tributary to the Minnesota. It has many branches; some of them nearly or quite as large as the main stream. There is here a remarkable confluence of several rivers flowing from the west, south and east, to a common center where they combine and discarge their united volume into the Minnesota. The drainage basin of this system comprises Watonwan, Martin, Blue Earth, Fairbault and Waseca counties. The total area of the watershed is 3350 square miles.

The stream which bears the name of the Blue Earth rises near the Iowa boundary line, and its general course is nearly north.

Its principal affluents on the west bank named in descending order, are the West Fork of the Blue Earth, Badger Creek, South Creek, Centre Creek, Elm or Chain Creek, and the Watonwan River. These drain Martin and Watonwan counties. The tributaries of the Blue Earth on the east bank named in descending order, are Coon creek, East Fork and Le Sueur river. Of these the most important is the Le Sueur, which joins the Blue Earth three miles above its mouth, and and at their confluence is the largest stream.

The Le Sueur has its source in the southern part of Waseca county. Its course is north, then west. It makes a rather large bend in Blue Earth county, and is joined first by the Cobb river then by the Maple river, at a point about six miles south of Mankato.

The Cobb and Maple rivers have their sources in the northern part of Faribault, and flow nearly parallel, in a northerly course, till they join the Le Sueur.

At the mouth of the Blue Earth the Minnesota bends to the north, and takes a general northeast course to its junction with the Mississippi. The cause of this deflection of its course is explained by the geological formations here, as set forth in another chapter. Below Mankato the Minnesota has few important tributaries. Its drainage area is now much more limited.

The principal affluents, in their order descending the river, are the following: The Shanaska, a small stream entering the Minnesota, from the east, at Kasota, in Le Sueur county. It is the outlet of Lake Washington. It has two water powers.

Cherry Creek enters the Minnesota from the east at Ottawa. It rises in the small lakes in Cleveland and drains an area of about 60 square miles.

Little LeSueur creek drains the northern part of LeSueur county, an area of 114 square miles and finds the river at LeSueur. It has two small water powers.

Rush river drains the northeast part of Sibley county, an area of 102 square miles and enters the river from the west.

High Island Creek has its source at High Island Lake or Auburn Lake. It drains an area of 75 square miles in northeastern part of Sibley county and joins the Minnesota from the west.

Sand Creek drains an area of 234 square miles in Scott county and enters the Minnesota from the east near the Little Rapids above Chaska. It has three water powers. Carver Creek drains

160 square miles in Carver county. Its sources are the lakes of Waconia. There are two small water powers.

Credit river flows north and joins the Minnesota. It drains 140 square miles in the eastern part of Scott county. It has one water power at Hamilton where it unites with the Minnesota.

Nine Mile creek drains 42 square miles of Hennepin county and finds the Minnesota from the west, being the last affluent.

The Red River of the North and its Tributaries Above its Junction With the Bois de Sioux at Breckenridge.

This is considered by some authorities as a distinct river and is called the Otter Tail river. In various reports of the War Department by engineers and others, the Red River is said to have its source in Lake Traverse and the Otter Tail river is regarded as a tributary. Dr. Owen, in his geological report of Wisconsin, Iowa, and Minnesota makes Otter Tail lake the source of thee Red River. H makes no mention whatever of the section of the river above OtterTail lake, and remarks of the Red River which he descended from Otter Tail lake to Pembina that it was called by the Indians "The Otter Tail."

The ultimate sources of this stream are not more than ten or twelve miles west of the headwaters of the Mississippi in T. 143, R. 38. There is in this part of the State a rolling, undulating tract, generally elevated between 1,500 and 1,600 feet above the sea. The hills and ridges rise variously from 25 to 100 feet above the intervening lakes. There are numerous swamps and marshes and lakelets, and the whole region is nearly forest-covered. Here, within a radius of a dozen miles, the Mississippi river, the Red river, the Wild Rice river, the Shell river and the Buffalo river have their sources.

There is a small, nameless lake about six miles north of Elbow Lake, where the river has its ultimate source. The stream flows south and passes through Elbow lake, Many-point lake and Round lake in the order named. Its course then trends southwest; it passes through Height of Land lake and continues in the same general direction some 15 or 18 miles further till it is crossed by the N. P. R. R. at Frazee. The course of the river is thence southeast as far as Pine lake, and thence south to Otter Tail lake. The elevation of the river bed above the sea near Perham is 1,327 feet. The elevation of Otter Tail lake is 1,325 feet.

Thus far the river has no clearly marked valley. It flows in a

channel eroded by its own agency in the drift. The banks vary from 6 to 20 feet high. Sometimes there are swamp-like expansions at one side or the other of the stream. At other points the banks are perpendicular or abrupt and the river has eroded the side of a bluff. But in general the characteristics of the river are those simply of a drainage channel, carrying off the surplus waters of the region. It is commonly termed the Otter Tail creek above the lake. Below Otter Tail lake the Red river assumes a somewhat different character. Having received in the lake itself two important affluents, it flows out at the southern extremity a swift, strong current between moderately high bluffs.

The country through which the river winds is exceedingly hilly and rough. The morainic deposits are composed of clay, sand and gravel, and the river eroding the sides of these hills and bluffs, becomes colored by the earthy matter held in suspension, so that it is milky or whitish-yellow in appearance. It passes through three or four lakes which are little more than expansions of the river where the conformation of the surface favored the spreading out of the water. Owen finds ten of these lakes, but some of them must have disappeared, for at present there are only three or four places that can claim that distinction. The descent is quite appreciable and the current generally rapid. In fairly high water the river rushes along with great power, and a ride in a batteau is an exhilarating pleasure. The fall from Otter Tail lake to Fergus Falls is 144 feet, the elevation at Fergus being 1,181 feet above the sea. The general course of the river, as may be seen by a glance at the map, is generally southwest, but meantime the windings of the channel direct its current toward nearly every point of the compass. Its flood-plain as a rule is coextensive with its valley, which has been entirely eroded apparently by the present river.

The Lakes.

The lakes of Minnesota form a very conspicuous feature of our natural scenery. The traveller from his car window enjoys glimpses of their quiet beauty as they lie nestled among the trees or shimmering in the sunlight on the broad prairie. Hundreds of visitors annually make a pilgrimage to their shady shores to find rest and health and recreation. The multitude and variety of these fresh water deposits, and the influence they have on the life and health of the people call for a more minute description and extended notice of them than is usual in works of this kind.

Number of Lakes.

The number of lakes in Minnesota is variously estimated at from seven to ten thousand. The latter number is not too high if all the lakes in the unsurveyed northern portion of the State are reckoned in. In ascertaining the number of lakes in a given county, one must decide first what shall be included under the term "lake." There are broad shallow areas of water some eight feet deep, nearly filled with reeds and rushes. There are small round or oval depressions in the prairie, having no inlet or outlet, which in this State are included under the general term lake.

If we embrace everything which land surveyors and map-makers have considered of sufficient importance to be delineated on their maps, we have a total number of 3759 lakes of all sizes. But the region where lakes are most numerous, the northern and north-eastern portions of the State, has been only partially surveyed, and there are no accurate maps of the country published. But from such information and data as we have, we have no hesitation in saying that there are within the limits of the State more than double the number of lakes already counted.

THE LAKES OF MINNESOTA AND THEIR DISTRIBUTION ACCORDING TO ANDREAS' ATLAS, BY W. UPHAM.

COUNTY.	No. of Lakes ½ mi. long or longer.	No. of Lakes less than ½ mi. long.	COUNTY.	No. of Lakes ½ mi. long or longer.	No. of Lakes less than ½ mi. long.
Ramsey	36	60	Isanti	27	1
Hennepin	66	32	Chisago	30	10
Washington	39	28	Todd	51	13
Dakota	11	1	Morrison	18	5
Scott	29	4	Crow Wing	38	5
Carver	49	25	Aitkin	37	....
Nicollet	21	6	Wright	99	160
Brown	23	3	Meeker	109	62
Blue Earth	33	14	Kandiyohi	104	182
Le Sueur	50	18	Swift	16	....
Cottonwood	33	11	Chippewa	6	....
Murray	36	11	Lac qui Parle	4	....
Pipestone	....	....	Canby	....	....
Rock	....	....	Yellow Medicine	7	....
Nobles	16	5	Lincoln	39	9
Jackson	24	1	Lyon	17	3
Rice	21	10	Redwood	18	1
Goodhue	3 *	2	Renville	15	1
Wabasha	2 mi.	....	Grant	43	34
Winona	2 mi.	2	Stevens	36	11
Olmsted	....	....	Traverse	2	5
Dodge	....	2	Big Stone	43	15
Steele	8	2	Clay	16	8
Waseca	20	16	Wilkin	1	....
McLeod	38	31	Becker	113	59
Sibley	32	7	Otter Tail	175	98
Freeborn	21	11	Kittson	1†	....
Watonwan	21	12	Marshall	....	....
Martin	60	6	Polk	5	....
Faribault	17	6	Beltrami	7	....
Mower	....	9	Itasca	43	6
Fillmore	....	1‡	Cass	181	25
Houston	1	....	St. Louis	36	....
Stearns	81	126	Carlton	8	....
Benton	3	2	Lake	5	....
Sherburne	20	3	Cook	13	....
Mille Lacs	6	....	Douglas	122	34
Anoka	43	40	Pope	61	29
Pine	34	7			
Kanabec	19	2	Total	2467	1292

Total of all sizes on Andreas' Atlas, 3759.

Including the lakes crossed by S. and E. county boundaries; but not those crossed on N. and W.

*Lake Pepin, &c. ‡Besides a mill pond. †L. of Woods.

Our lakes may be classified according to the character of their basins and the causes which have produced them, as follows:

A. The glacial or drift lakes, which occupy depressions, chiefly within the morainic area, between the hills of drift material Many of these lakes are very small and have no outlets. This class comprises the great majority of our lakes.

B. The fluviatile or river lakes which occupy basins on the course of rivers or within their valleys. Sometimes they are lagoons, marking the site of an ancient river-bed; sometimes they are enlargements of the river channel. Their number in this

State is quite limited. Not infrequently a lake seems to belong to both these classes.

C. Lakes having rock basins, which have been formed (1), by erosion, the glacier scooping out the softer rocks and leaving a channel or trough which has subsequently been filled by water, or (2), by the geological relations of different formations, which are tilted or otherwise disposed so as to leave a rocky basin.

The drift or glacial lakes are distinguished from each other in respect to the quality of the water. In some, especially those without drainage, lying in a clay soil and receiving their supplies from the adjacent watershed, the water is alkaline.

In those lakes, the shores of which are composed chiefly of sand and gravel, and which have free drainage, receiving their supplies by several creeks or inlets, the water is comparatively free from alkaline properties. It is the character of the soil which constitutes the water-sheds of a lake or river that determines the quality of the water. In the northeastern portion of the state, which is crowded with lakes and no inlets, the water is comparatively free from mineral impurities. Sometimes, as in that of the St. Louis river, the water is a dark wine color, caused by the leeching of the rainfall through spruce and tamarack swamps which the river drains. The soil in this region is mainly silicious. As quartz is soluble in rainwater, the rainfall comes to the creeks and lakes not nearly pure, or colored only by some vegetable extracts.

The great lacustrine areas of our globe are north of the 45°of latitude. Comparatively few important lakes lie south of this parallel in either hemisphere. By reference to the atlas, it may be seen that the lake regions of the earth are coextensive with the drift regions; that the countries which were once covered by the glaciers are the ones which now abound in lakes. Sweden and Switzerland, and Scotland and Ireland are examples in Europe.

In North America, the lacustrine area extends in a broad belt from MacKenzie's River southeastward to the Newfoundland. It includes the St. Lawrence system and the vast inland seas of British America, of which so little is known. Although these lakes belong to different river-systems, and vary widely in their geological relations, they have, I think, a unity of origin, and serve a similar purpose in the economy of nature.

Our Minnesota lakes lie on the southern margin of this area. There is a fixed relation between them and the morainic deposit in which they lie. They are most numerous where the evidences of glacial action are most abundaut. The position of the great

moraine might be traced from the northern bounkary of the state, south and southeastward through Beltrami, Becker, Ottertail, Douglas, Pope, Kandiyohi, Stearns, Wright, Hennepin, Carver and LeSueur, and south into Iowa, by the number of lakes which adorn the surface of these counties. It should be carefully noted that outside the limits of the morainic area, lakes are few, while within those limits, they are numerous. The northeastern part of the state also contains a vast number and variety of inland waters, some of them tributary to the St. Lawrence, and others to the Mississippi. These lakes are, many of them, of a different character, having rock basins, occupying clefts and troughs between differ entgeological formations.

ORIGIN OF THE LAKES.

The most uninstructed observer can see that large areas of the State now utilized as meadow-land, or under cultivation, were at no very distant day under water. The process of converting shallow lakes into swamps or sloughs, and these into solid, dry land, has been going on for ages, and is constantly taking place under our eyes. It is still more evident to the scientific observer that nearly the whole State was covered by an ice-sheet or glacier. The evidence on which this theory is founded, will be found in another chapter.

It is only necessary to remark here, that the surface features of our State with which we are all familiar, hill and valley, river courses, lakes and prairie undulations, were determined either during or subsequent to the glacial epoch. The lakes especially, are intimately related in a geological sense, to the glacial deposits. They were formed and their positions determined, by the same causes which produced the drift hills. One is as old as the other. They are both the children of the glacier. The principal hills of this State lie within the morainic area which marks the retreat and melting of the ice-sheet. Here also in great numbers and beauty, the lakes are found, nestled in the intervening valleys, occupying the hollows and depressions. Whence arises this companionship, which gives so much variety and loveliness to the scenery.

Let us try to imagine the condition of affairs during the closing of the glacial period in this State. The great ice mantle is slowly dissolving before the gentle assaults of a milder climate. Its retreat is not rapid, and is frequently interupted for a time by the

return of winter. Some portions of the glacier are more heavily loaded with the material of which our hills are composed, than others. These parts melt faster than the purer ice. The result is that cakes of comparativly clear ice lie between the great dark accumulations of gravel, boulders, sand and clay. Torrents of water, caused by the melting, flow from the foot of the glacier which fill up every depression and nook of every sort. These are constantly at work modifying and rearranging the materials which the ice has deposited. Only superficial portions of this material are subject to this modification by water. The deeper deposits, the *moraine profonde* is undisturbed. The coarser gravels and boulders are only slightly stirred, and arranged in a rude stratification or thrown pell-mell into some cavity in the clay. The finer gravels and coarse sand are carried further and spread out in thin layers on some old flood plain, while the lighter and finer sands are carried by the great flow of water far down into the river valleys. Over all hung clouds and mist, while descending rains and fierce winds swept over the wild and dismal scene. But at last all this comes to an end. The glacier is melted. The surplus water is carried away. The hills with their softly rounded outlines and steep slopes, stand forth clothed in verdure, while around their bases, and filling the deeper depressions, the lakes, somewhat in their present form, though deeper and larger, are all that remain of the glacial flood.

CAUSE OF PERMANENCY.

Our lakes have remained a fixed feature of the landscape since glacial times, for the reason that the slope of the watershed is so slight and the erosion by rivers and outlets so little. When a depression in the earth's surface is once filled with water, it remains a permanent lake so long as the drainage and evaporation do not exceed the amount of water received from the rainfall and other supply sources.

The character of the basins of the glacial lakes of Minnesota also tends to secure permanency. The slope of the bottom from the shore toward the center of the lake is usually very gradual. The deepest water is generally found about the center. Many lakes lie in separate basins connected by a narrow channel. The clay which constitutes the bottom of a large number of lakes is very hard and compact. The blue clay especially is almost impervious. These conditions combine to hold the supply of water se-

curely. It follows from these considerations that the lakes, when once formed, must remain, since the agencies tending to destroy them are not equal to the sources of supply and stability.

Moreover, it is evident from a careful consideration of a multitude of lake basins, that the annual mean rainfall has been for a long period about what it now is; that the lakes received more of that rainfall than they now do. The loss by evaporation and drainage together did greatly exceed the supply. The lakes very generally held their own or receded very slowly from their ancient levels.

Our lake shores are rude meteorological registers. They show that the same conditions of climate, of cold and heat, of moisture and dryness, that exist now, have prevailed for centuries. A lake once formed, remains at a constant mean height, so long as the agencies tending to destroy it are counterbalanced by steady sources of supply.

CAUSES WHICH OPERATE TO DIMINISH THE NUMBER AND SIZE OF OUR LAKES.

It is, however, beyond question that the present tendency of our lakes is to retreat within narrower compass. A very wet season brings them up for a short time to the vicinity of the old high water mark, but they never reach it, and they quickly recede again to their usual low levels. The shallow lakes which have no visible inlet or outlet are slowly drying up. Those which form a part of some river system, which receive the drainage of some lakes or have other regular sources of supply will maintain their present level indefinitely. But there are a large number of shallow lakes which are rapidly being transformed into marshes. In a few generations, probably, they will become excellent meadows.

Among the causes which co-operate to produce this change, the agency of man is perhaps the most powerful. Before the settlement of the country the lakes and streams received a larger share of rain fall directly. The undisturbed prairie sod sheds water almost as well as the roof of a house. Any one who has driven over the unbroken rolling prairie in a wet June and on a rainy day when the pools are full has seen the water rushing along over grassy hollows and in gentle depressions where no water-course would be suspected in a dry season. Thus, when nature operated without interference, the rainfall speedily found its way over the grassy prairie sod into the lakes. But when then the farmer came

with his plow and tore up the sod and cultivated the fields the water remained nearly where it fell and the lakes also "fell" correspondingly. Their supplies were cut off in every direction by the growing crops which formerly found their way directly into the lakes and streams.

The growth of water-plants and reeds also tends to fill up the lakes. The bottom of nearly all the shallow lakes is covered by a thick matting of trailing plants, some of which are interesting and beautiful. Nothing can be more graceful than this sub-aqueous vegetation. Leaning from the side of a boat on a calm day in summer one may feast his eyes on little and delicate forms of beauty growing in minature forests and jungles, where the larger bass and walleyed pike love to lie in cool and shady seclusion. But all this luxuriance of vegetation tends to transform the lake which covers and protects it into an unlovely morass.

There is no evidence, and we have not the data on which to base a conclusion, that the rainfall a century ago in Minnesota was greater than it is now. But the lakes are certainly drying up. The rate of the recession of the water is greater since the advent of civilization than it was before. The rainfall continues about the same since 1836 when observations were first taken at Ft. Snelling.

The inference is that a smaller share of the rainfall reaches the lakes now than formerly. It is absorbed by the growing crops. It has been ascertained by careful measurements and repeated experiments in France that it requires the expenditure of from 800 to 2,400 pounds of water to produce one pound of wheat. When the ground is rich in the chemical constituents of the grain less water is required. This may account for the fact that the lands in the Red River Valley, where the mean annual rainfall is only 17 inches, produces 30 to 30 bushels per acre. Where the soil is inferior, as much as 15 inches is required between seed time and harvest by a crop of wheat or oats.

ACTION OF ICE ON LAKE SHORES.

One of the constantly recurring features of the shores of most lakes is a low ridge or embankment of sand, gravel and boulders, running parallel with the water line, and distant from it from ten to sixty feet. Sometimes there are three or four of these ridges, at various distances from the water. The outer one, if undisturbed, is the highest and not uncommonly supports trees of large size. These "embankments," or "walls" as they have been called,

have excited the curiosity of people a good deal and there has been much lively speculation as to their origin. Some have supposed they were thrown up by the primitive inhabitants of these lands —whoever they were—for roads. But a very little attention to facts is sufficient to convince any one that these ridges are due to the action of ice, aided, in some cases, by the high winds and waves of early spring. When the lake freezes in winter, the shallow parts about the shore freeze first. The ice takes up in its frigid grasp all loose stones, pebbles, grains of sand and dirt lying at the bottom and around the margin of the water. But this shore-ice is not permitted to remain in the position where it was formed. A mechanical pressure is brought to bear on it by the further freezing of the surface of the lake. It is lifted and pushed up on to the beach by expansive force of freezing water.

The phenomena of the formation and effects of lake-ice are so interesting that a brief account of them is given with a view not only of explaining the walls and ridges about our lake-shores, but with the hope of inducing those whose good fortune it is to reside near a lake, to observe more closely the facts and phenomena for themselves.

PHENOMENA OF FREEZING.

To take a special case, Lake Minnetonka froze over in November, 1880, earlier and more suddenly than is usual. The first ice formed around the edges of bays on November 7th. Several days of stormy weather, rain, snow and northwest wind, followed, and the lake was very rough, nevertheless the ice continued forming more and more in the bays. The temperature of water at the surface was continually falling. On the first of November it was 45° F., and on the 16th it was 37°. Then came a storm and very cold weather. The thermometer registered 7° below zero on the morning of the 17th. Excelsior bay and Gideon's bay froze over, and on the 19th the entire lake was covered with ice, the thickness being six inches about the shores and two inches further out. During the night on the 20th inst., the ice cracked in many places with a loud report. Exquisite ice-flowers, sometimes an inch broad, appearing like a miniature forest, were very numerous. These are all modifications of the typical, six-rayed ice-star.

I have given this brief account of the sudden freezing over of one of the largest of our lakes in the middle of November because

it is an illustration of what took place on all the 10,000 lakes at the same time.

It is a well known principle that frozen water requires more space than the same amount did in the liquid form. Water in freezing expands.

Water attains its maximum density at 39° Fah. Below this point it expands. At 32° fah. it begins to turn into crystals of ice, which float on the surface because comparatively lighter than the water. At 32° the expansion by cold terminates, but in the final act of solidification the expansion or increase of bulk is sudden and irresistible. Conceive of a large lake like Minnetonka freezing over to a depth of two to six inches in twenty-four hours. A vast quantity of water is turned into ice every hour. The expansive force of the crystalizing water is exerted in every direction at once. The strain is tremendous. The ice cracks and loud reports are the accompaniment and evidence of this action.

As the cold of winter continues and increases, the ice becomes thicker and the increase of bulk continues to demand room. The ice in the borders of the lake is now pushed by inherent force of the great mass up on to the shores, carrying with it rocks, pebbles, and whatever it may have caught in its grasp. The broken ice on the edges of the lakes is a familiar sight. The causes which produce these phenomena are here indicated.

In these low embankments or ridges of gravel and sand about the shores of lakes, we see the effects of years, perhaps of centuries, of ice action. When the lake stood at a higher level than it now has, the ridge most remote from the present shore, was slowly formed by causes identical with those now at work. Year after year the ice crowds upon the shore with its weight of sand and gravel, here from the bed of the lake. Winds and high waves assist in the process and thus, in the course of successive seasons, a very large accumulation of material is formed.

The line of boulders along the shores of some lakes, deposited with an apparent regularity that makes them resemble, at a little distance, a low stone wall, is due to the action of ice. These boulders are scattered through the drift formation, which constitutes usually both the shores and the bed of the lake. Where the shores are high and abrupt, the boulders sometimes fall from above into the lake. Whenever a loose stone comes within reach of ice it is taken and moved about, lifted up and shoved upon its fellows.

Value and Utility of Lakes.

The value and utility of our lakes are not to be computed according to the market price of the land adjoining. They constitute together a natural feature of the state which, like the salubrious and invigorating climate, the fertile soil and vast forests, is a part of the common wealth. No matter who owns the adjacent acres, the lakes themselves are public property, and we are all richer and happier because they are here. They have however a definite utility in two or three respects that demand mention.

1. The sanitary or hygienic value of our lakes should be recognized. Whatever contributes to promote the health and happiness of the people, is important. The lakes furnish a constant opportunity and temptation to the residents both of city and country to take hours of healthful exercise and recreation. They are usually well stocked with fish, and haunted during the autumn months by myriads of wild fowls. Aside from their attractions for the sportsmen, there is, for all classes of people, a relaxation from mental and physical strain, a wholesome pleasure, a recuperation and invigorating effect produced by spending a few weeks or even a few days on and about these lakes. Health is capital; and beyond question, our people derive from these crystal waters a fund of enjoyment and vitality which materially augments the prosperity of the State.

But the charms and benefits of the lakes of Minnesota are recognized and appreciated quite as much by the citizens of other States as by our own people. Every summer, in very increasing numbers, they come from all parts of the Mississippi valley, from New Orleans, from Memphis, from St. Louis and elsewhere to find a stimulating climate and healthful recreation at our lakeside resorts. And what an immense number of such resorts there are which are unoccupied. The capacity of Minnesota to set forth entertainment in this line, is inexhaustible. Thousands of beautiful lakes scattered over the whole lake district invite the tourist, the sportsmen and visitor to their shores. There is room for all. We might almost say that there is a lake for each one. When the resources and beauties of our inland lakes become more widely known, their practical value as a source of income to our citizens will be better appreciated. To make these lakes more accessible to provide boats and comfortable houses of entertainment, is one of the natural and legitimate industries open to our people.

2. The climate is modified to some extent, by the lakes. Dur-

ing the summer these small bodies of water become reservoirs of heat. The temperature of the lakes during the summer months, as determined by repeated observation, is about 75° Fah. The whole mass of water is heated alike; the temperature of most lakes at the bottom is the same, nearly, as the top. The capacity of water for absorbing and retaining heat is well-known.

During the summer, heat is absorbed from the direct rays of the sun. During the fall, up to the hour when the lake freezes over, this heat is slowly given off and exerts a sensible influence on the surrounding atmosphere. Gardens and vines favorably situated on a lake side escape the frosts of autumn longer than others. No doubt the transition from summer to winter would be more abrupt and severe but for the large amount of heat latent in water which is given off in freezing. "Every ton of water converted into ice gives out and diffuses in the surrounding atmosphere as much heat as would be required to raise a ton of water from 32° to 174° F."

3. In many instances lakes have been utilized as reservoirs from which to draw supplies for mills and factories as necessity requires.

By constructing dams at the outlets a vast amount of water may be stored during the spring and early summer in these natural reservoirs. The value of water powers may thus be greatly increased. Among the plans contemplated by our national government for the improvement of navigation on the Mississippi river is that known as the "reservoir system." It is nothing more than the utilization of the lakes and marshes of the upper Mississippi above Pokegama Falls, for the purpose of storing water during the winter and spring, up to July 1st, so as to maintain during the season of low water from July to November a steady stage of water at St. Paul and below, sufficient for all purposes of navigation. A further account of this proposed system of reservoirs is given on another page in the section describing the headwaters of the Mississippi.

Although with few exceptions lakes are distributed in all parts of our State they are far more numerous and interesting in the central and northern counties. The belt of country, which by reason of the great number and beauty of its lakes deserves the name of the *Lake District*, begins with lake Minnetonka, in Hennepin county, and extends northwest to the northern line of Becker county. The district is from 30 to 50 miles wide. It is bounded on the south by the Breckinridge division of the St. P. M., & M.

R. R., while the Fergus Falls division of the same road passes directly through it. The Northern Pacific R. R. passes through the northern limits of the district.

Another lake district exceeding in extent of territory and in the number of lakes the one described above, begins in Becker county and extends east and northeast through Cass, Itasca, St. Louis, Lake and Cook counties to the chain of lakes which constitutes the boundary line between the U. S. and Canada. In this district lie the head waters of the Mississippi, the Red River of the North and the St. Louis river. These lakes will be described when we come to consider the hydrographical basins of the rivers in which they are situated.

At present we will give an account of the lakes in the first district mentioned, which lie partly in the water-shed of the Mississippi and partly in that of the Red River. For the purpose of assisting those who are not familiar with the geographical position of the lakes to locate them readily on the map, I shall describe the lakes in the several counties of the district.

Lake Minnetonka is one of the largest, as it certainly is the most widely known and celebrated, of our lakes. On account of its accessibility it monopolizes the admiration which would be shared by other lakes equally charming, but for their remoteness from railroads and large cities. There is, however, no lake in the State that excels Minnetonka in that general attractiveness, which is a happy combination of clear, wholesome waters, hard, pebbly and sandy beaches, shady, wooded shores with irregular outlines and unequal heights, points, promontories, islands, bays, in short, a delightful interlocking of land and water.

The lake occupies a series of depressions in the great moraine, which at this point bends south, and extends down into Iowa. Minnetonka is a name which includes a cluster of bays and lakes more or less connected together by shallow straits. The upper and lower lakes are quite distinct, only a narrow and crooked channel uniting them, which has now, however, been straightened and deepened to allow the passage of steamboats.

A little attention to ancient water marks and ice action about the shores, will convince the close observer that the level of the lake was formerly much higher than it is now. There was once a broad, though probably rather shallow, belt of water between the upper and lower lakes, which is now so filled with rushes and reeds and grasses that it has become a morass. All about the shores are swampy places, some of which have become almost dry land, where

the lake once held undisputed possession. Many lakelets which now have no connection with the main body of the lake, except perhaps in time of very high water, were at one time arms or branches with clearly marked water communications. The former level of the lake was probably five or six feet above the high water mark of the present time. A remarkably fine lake, however, remains, and one which is in no immediate danger of drying up, although a constant diminution in the area of water surface is going on. The depth of water varies greatly in different localities. The bottom of the lake is very irregular. There are valleys and ridges beneath the surface of the lake corresponding to those above. A great number of soundings have been taken and registered, some of which are given on the maps which accompany this report.* In the lower lake the deepest parts are in the centre of the largest basin, that is, the area included between the lower end of Big Island, Starvation Point, Lookout Point and Gibson's Point. The depth in this basin varies from 40 to 70 feet.

Brightwood or Gale's Island is the summit of a little hill which rises from 50 to 75 feet above the bottom of the valleys that surround it on three sides.

Crystal Bay is deep; both above and below Cedar point, the water fills a basin the bottom of which is from 40 to 70 feet below the shore line.

The upper lake is deepest between Halsted's place and Enchanted island. The water in the basin is from 50 to 70 feet deep. The bays generally are shallower, showing not more than 25 or 30 feet of water usually, in the deeper parts. On the bars and ridges there are from 4 to 10 feet of water.

Wright County

adjoins Hennepin on the northwest. It is drained chiefly by the Crow river. In the northern part of the county, the Clearwater river, with the lakes of which it is the outlet, drains a considerable area. There are 160 lakes within the limits of the county, of which Clearwater lake is one of the largest and most celebrated and attractive as a summer resort. It is the lowest of a chain of lakes on the Clearwater river. Its position makes it the reservoir of the watershed of the river above it and keeps it supplied with the drainage of an extensive region. The quantity or volume of water in the lake therefore varies but little. It differs from a large

*This map is reserved for future publication.

number of lakes which we shall have occasion to describe, in maintaining a more equal and constant height from year to year. A lake through which a river flows, has the conditions of a more permanent and stable existence than one which depends for supply only on its own water-shed.

The northern part of the lake is generally shallower than the southern. There are large areas where the water is not more than four to six feet deep and aquatic plants flourish. In the deeper parts from 25 to 40 feet of water were found, and in one place 54 feet, but these deeper areas were quite limited in extent. In the northern basin are two islands, covered with trees andshrubs. They are the summits of little hills whose bases are covered by the lake.

The surrounding country is rolling and uneven. Around the southeast part of the lake the shores rise abruptly from 10 to 40 feet. At other points the shore is low and level. There is comparatively little marsh except where former lakelets have succumbed to the influences which are silently yet surely drying and filling up every lake in the State. The inequalities of the lake basins, as revealed by the sounding line, are only a part of the general contour of the surface of the country.

The lake is divided by a bar into two nearly equal parts. The bar is a low ridge of gravel, rising but few inches above the lake level. The water on either side for some distance is shallow, and then suddenly falls off to a depth of 30 to 50 feet, showing that the bar is the crest of a hill or ridge. The channel at the end of the bar, connecting the two parts of the lake, is from 28 to 38 feet deep and about 30 to 40 feet wide. Thus there are two distinct basins. The southern basin varies in depth from 4 to 60 feet. The bottom is very irregular, in some places, as at Longworth's house, sloping gradually down and at other points falling off abruptly. Some of the deepest water is across the lake from Longworth's and four or five rods off shore. The greatest depth measured was 60 feet, and from 30 to 50 feet were found repeatedly.

Meeker County

lies west of Wright, and south of Stearns. It is drained by the Crow river, the north branch of which flows through the northern half of the county, while the south fork drains the southern townships. Between these streams, and generally connected with them, are a great number of small lakes;

about 110 in the entire county, and as many as 170 if we include the smallest.

One of the largest is Lake Ripley near Litchfield. It is about two miles long and a mile wide. The country around the lake is either level or gently rolling. The Litchfield prairie is nearly level. There is only a difference of two feet in elevation between Darwin and Litchfield.

Lake Ripley

occupies a very shallow depression in this prairie. The bottom of the basin is level and slopes very gradually down from the water's edge, to a depth of 20 feet.

There is evidence about the shores that the lake formerly stood at a higher level than it now reaches, even at high water. The ancient shore-line is clearly marked. There is an accumulation of gravel and boulders at several points, which must have been deposited by the action of ice and water, that is from 3 to 5 feet above the present level, and from 20 to 50 feet distant from the present water line.

The outlet of lake Ripley in time of high water is into the Crow river. It depends for supply, on its own water shed and the drainage of an extensive slough adjacent.

Lake Minnabelle

is about six miles south of Lake Ripley. It has no apparent outlet. It lies in a deep basin of considerable depth, and surrounded by a rolling prairie country. The greatest depth found was 43 feet, in the central part of the lake. There seemed to be quite a uniform depth of 25 to 40 feet. The bottom of this basin must be in the clay, as borings for wells near the lake indicate that the clay extends down for at least 90 feet. This clay at the depth of 90 feet, became so hard that the attempt to get water, was abandoned.

The basin of Minnabelle may be regarded as "water-tight." The evaporation from the surface is small in proportion to the whole amount of water in the basin, and the annual rainfall keeps the supply constant.

Washington Lake.

is near Darwin on the west side of the belt of timber known as

the "big woods." It is entirely surrounded by forest. It has an area of about 4 square miles, and is supplied by the drainage of two small lakes lying west of it and constituting the headwaters of a creek, which enters the Crow river below Kingston.

The shores are unequal and irregular in height, varying from 6 to 30 feet. The depths of the lake, so far as they could be ascertained, also vary from 6 to 18 feet. Large areas of the lake are quite shallow, with a luxuriance of water plants.

Kandiyohi County.

For convenience in description the lakes in the southern part of this county may be grouped together. They possess in common the characteristics which are noteworthy. The surrounding country is a gently rolling prairie which slopes very slightly south toward the Minnesota valley. There are no high hills or deep valleys. The shores of the lakes slope very gradually to the water line or are entirely flat and featureless. The lakes are Lillian, Big Kandiyohi, Elizabeth, Little Kandiyohi.

They are all shallow, varying in depth from seven to twelve feet in the deepest parts. The water is slightly yellowish in color and alkaline. They lie on clay bottoms, over which is a thin deposit of sand. The temperature of the water was 74° F. on the 28th of June, when the temperature of the air was 67° to 70° F. They have no large inlets from perennial streams. They receive the drainage of contiguous sloughs, and in very high water they form a temporary outlet into the south fork of the Crow river, which has its ultimate sources in these lakes. There is a difference of only about one foot between the levels of these lakes. Kandiyohi and Elizabeth are a trifle higher than Lake Lillian.

There are no forests in this part of the county. There is a fringe of trees about the shores of the lakes and some valuable groves of oak, ash, elm, box elder, basswood, poplar and a few hickory trees. I also observed the wahoo growing here. In Lake Elizabeth are two islands, and on the western side the prairie slopes down rather abruptly, giving a picturesque and pleasing effect.

The lakes in the northern part of Kandiyohi county are of a different character. The country, as a whole, is more hilly and uneven. The moraine, traced by Mr. Upham, enters the county from the northwest, and extends entirely through the northern part. This morainic tract is in some places, very rough and broken. The hills are from 100 to 150 feet above the lake levels.

Dover hills are about half way between Willmar and Norway lake. The summit of the highest commands a fine view, and is about 150 feet above Foot lake. Several other hill-tops north and west of Green lake were measured for altitude by me, and found to be from 1200 to 1350 feet above the sea. One of the highest of these summits is on the north side of Green lake, and commands a very extensive and magnificent view. It is 200 feet above the lake level.

In this part of the county there is considerable timber and woodland. Hundreds of acres are covered with valuable forest trees. The principal varieties are oak, basswood, elm, ash, ironwood, poplar, cottonwood, hackberry and box-elder. Around Eagle lake there are some butternut trees. The principal shrubs and small trees observed were plum and cherry trees, prickly ash, gooseberry, wild currant, juneberry, red-raspberry, black-raspberry, cornus, elder, snowberry and wild grape.

Although a good deal of attention has been given to the subject of tree-planting in this county, and some fine young groves are to be seen, yet the farmers as a whole are painfully short sighted in this respect. So long as there is wood enough for present necessities, no earnest effort will be made.

Men care little for the future. They seem content to live on the bare, bleak prairie without a tree or shrub about them, rather than make the necessary effort to have a thrifty grove of forest trees growing up about them.

The old forests at present are disappearing much faster than the new ones are growing. Indeed, nothing that can ever be called a forest is attempted. Only a few acres of cuttings are set out here and there. These are in many cases neglected and destroyed by drought or fire.

Some more vigorous effort must be made, either by legislation or by town and county action, before this matter of tree culture will receive the earnest attention which its importance demands.

The largest body of water in the county is Green lake. It is about four miles long—east and west—by three miles and a half wide. It derived its name from the color of the water, which at times is intensely green, changing to blue, purple and darker hues. The unceasing play of color in the water is one of the great charms of this very beautiful lake. The principal inlet is at the northwest corner, where there is a flour mill. The outlet is at the northeast corner. It discharges into the north fork of Crow river.

There is a bar about the middle of the lake running nearly across.

I did not sound the lake in all its parts, but found in the western half 40 to 50 feet of water of the purest quality. The temperature, July 1, 1880, was: Air 78° F, water 74° F. I did not discover any appreciable difference in temperature between the water at the top and at the bottom of the lake.

Fluctuations in the water level appear to depend on the amount of rain-fall. Within the last ten years it has been from 10 to 12 inches lower than now, and also from 6 to 8 inches higher, according to the season.

Green Lake lies in a depression at the foot of the moraine which sweeps away on the north side toward the east and on the west side toward the south. Its position with reference to these hills and the country north is such that it must remain a permanent reservoir.

Its shores are bold and abrupt on the north and west sides—more level on the east and south sides. Near Mr. Aspenwall's the bluff is forty to fifty feet above the water.

ACTION OF ICE ON THE SHORES.

Beautiful illustrations of the action of ice in piling up sand and gravel are also to be seen here. The ancient ridge is now a roadway and has large trees growing on it. It is 40 to 60 ft. from the water. The most recent ridge is close to the water's edge. It is four or five feet high and five to eight feet wide at the base. It is composed of fresh gravel and has been thrown up within the past four years.

Between Green lake and Willmar there is a chain of lakes.

Eagle Lake.

Of these I shall only describe Eagle lake, which is about four miles north of Willmar. It lies in a depression at the foot of a spur of the great moraine. Its waters are clear and sparkling. Its northern shores high and picturesque and well wooded. Some of the hills are from 75 to 100 feet above the lake. Its outlet in high water is at the south end, and it drains into Swan and Foot Lakes.

There are springs about the northern shores and a small inlet from a slough or drained lake, on the east.

Its altitude above the sea is about 1125 feet.

Foot lake, at Willmar, is very shallow, and the waters in summer very impure, full of decaying vegetable matter. It is partly filled with a vigorous growth of reeds, and its days as a lake are nearly numbered. I sounded it in several places, and found a depth of 6 to 12 feet. It has receded from its former limits very perceptibly since the town was started. It is now at least five feet lower than it was in 1857.

Diamond Lake.

Diamond lake is a clear and beautiful sheet of water about five miles southeast of Green lake. The prairie around is massive, rolling, with no abrupt hills. The lake is two to three miles long and a mile or more wide. The greatest depth found was 26 feet. The temperature of the water on July 2, was 74° F., air 71° F. at sunset. Its outlet joins that of Green lake. The shores slope gently to the water's edge and bear a fringe of native forest trees. Evidences of a former higher lake-level are abundant.

In the northwestern part of the county is a chain of very charming lakes. These are Norway lake, James lake, Swan lake and Lake Andrew.

The moraine trends along the north side of these lakes. They lie in a series of depressions at the southern base. All the country south and west is massive, rolling prairie.

Norway Lake.

Between the lakes and to the eastward there is considerable hard-wood forest. Norway lake is not deep, and at the time I visited it, October, 1880, there was a minimum stage of water. There is a depth of 30 feet in some places. It is well cut up with bars and points. One of these, belonging to Mr. Even Railson, is a mile long and covered with fine hardwood timber. The margin of the lake supports a thick growth of reeds and rushes. The water is clear and translucent. In the fall it is the abode of thousands of water-fowl, and is a sportsman's paradise. Evidences of former higher water are very abundant. The old beaches are clearly defined. I am told that in 1871 the lake was six feet higher than it is now, and also in 1860 there was a very high stage of water. At such times these lakes have an outlet southwest into the Chippewa river: but in a dry season and low water there is no

outlet. These lakes usually freeze over between the 1st and 15th of December, and open in the spring between the 1st and 15th of April. The temperature of the water, October 10th, was 63°F. Lake Andrew is deeper than Norway, and there is a great variety of shore line. Together these lakes constitute one of the most delightful groups in this region.

The natural drainage of Kandiyohi county is chiefly into the Crow river. The northeastern townships are drained by branches of the north fork, while the southeastern towns, south of the railroad, are drained by the south fork. The western tier of towns are drained by branches of the Minnesota river, the Chippewa and the Chetomba. There is not an exposure of rocks in the whole county. The drift, which is very heavy, undoubtedly overlies the archæan terrace, which extends across the State from Lake Superior southwest. The "summit" near Atwater, where the railroad grade reaches an elevation of 1,264 feet above the ocean, is probably due to the greater uplift of the underlying rock rather than to any greater thickness of the drift. The drift pebbles on the shores of lakes are granitic or gneissic and limestone, about 65 per cent. of the former to 35 of the latter.

The principal lake of Pope county is Lake Whipple. It has an average length of seven miles, and width of two miles. Its area is about 15 square miles. It is situated in the northern central part of Pope county. It lies very picturesquely at the foot of the great moraine, at an angle where its development is most typical. On the north and eastern sides the morainic hills rise irregularly above the lake to a height of from 50 to 200 feet. At the northern extremity of the lake the quiet little village of Glenwood consists of a few houses at the foot of the bluff. Going up to the top of this bluff, which is more than 200 feet above the lake, one may enjoy as delightful a bit of natural scenery as there is in central Minnesota. From this summit the prairie stretches back to the north and west quite flat and featureless. Lake Whipple seems to occupy the bottom of a great basin around which the morainic hills of unusual boldness and height gather on every side, except the west, where is the outlet of the lake into the Chippewa river. The depth of Lake Whipple, at the northeastern end, near Glenwood, varies from 12 to 30 feet. It is quite shallow along the western shores, and there are a number of sloughs and lakelets which drain into the larger lake. There are numerous springs about the northeast shore, and water is found in the wells of the village at depths of 14 to 40 feet. The water stratum is of sand underlying

a bed of blue clay. The temperature of the water, on the 13th of July, was 77° F.

Lake Reno.

Lake Reno, on the northern boundary of Pope county, is a prairie lake about four miles long and two miles wide. Its northeastern extremity is much narrower. It has an area of about six square miles. It is separated by a sand-bar, from Maple Lake on the north. The surrounding country is rolling prairie nearly level. The banks of the lake show a subsoil of light yellowish clay. They are not more than 10 to 15 feet above the water, and usually slope gently back, without any abrupt or precipitous shores at any point. The lake has an even clay bottom, and in the central part, has an average depth of about 20 feet. There are very few reeds or rushes and no islands. At the northeastern end there is considerable timber, the principal forest trees being the oak, maple and basswood. The larger portion of the surrounding country is prairie. The water is slightly alkaline and of a yellowish hue, characteristic of broad and rather shallow lakes which are easily stirred to the bottom, by the winds. The temperature of the water, on the 28th of Aug., was 72° Fah. The outlet of this lake in high water, is into the Chippewa river. Its inlets are temporary streams from the adjoining prairies and sloughs.

Douglas County.

The lakes of Douglas county, are unsurpassed for the purity of their waters, the beauty of their scenery and general attractiveness. A glance at the map will show that there is a large number of them. But it is not their number so much as it is their beauty and variety which impresses any one who studies them in detail.

NATURAL DRAINAGE.

The western half of Douglas county is drained by the Chippewa River and its tributaries, while the eastern half is drained through the Long Prairie Chain of lakes into the river of that name which, beginning at Lake Carlos, of which it is the outlet, flows east and then north through Todd county, and discharges into the Crow Wing river near Motley.

TOPOGRAPHY.

The "leaf hills," whose greatest developement is in the southeast part of Ottter Tail County, are represented in the northern townships of Douglas. There are some conspicuous eminences on the north and west shores of Lake Christina. These hills rise from 75 to 150 feet above the lake. The highest point reached by the railroad near the southern boundary of the town of Lund, is 1378 feet above the sea.

Lake Christina is about 1215 feet above the sea. The general average of hill and valley is between 1230 and 1350 feet above the ocean. Evansville station which is one mile south of the town line, has an elevation of 1354 feet, and the Chippewa river near Stowe's Lake, is 1339 feet above the sea. Some of the highest points in the town are on sections 23, 25 and 36. The northern sections of the adjoining town of Millerville, are high and hilly. The township of Leaf Valley as its name implies, is a broad basin.

In Miltona a range of morainic hills extend southwestward past Lake Miltona and west of Lake Ida, through the town of Mohr to lake Oscar and beyond. At lake Oscar are some very prominent and massive hills, rising from 100 to 200 feet above the lake. This central ridge of the country is the "divide" separating the waters which find their way into Long Prairie river from those which flow westerly into the Chippewa. Alexandria which is situated on a high prairie a little east of this central ridge, has an elevation of 1392 feet. Lake Ida is a little more than 1400 feet above the sea.

The Long Prairie Chain of Lakes.

In the eastern half of Douglas county there is a chain of lakes remarkable for their purity, depth and beauty. They are all connected and lie within a radius of a dozen miles of Alexandria. Beginning with the most northern and the highest of the chain, they are Irene, Miltona, Ida. Louise, Mill, Andrew, Mary, Lobster, Fish, Latoka, Cowdrey, Darling, Union, Bergan, Childs. Victoria, Geneva, Le Homme Dieu, Carlos. Only the largest and most important of these can be mentioned.

Lake Miltona

is the largest of the chain. It has an area of about nine square

miles. It is six or seven miles long from east to west, and about two miles wide. It has two inlets, one at the eastern extremity and another at the northwestern. Its outlet on the southwestern side discharges into Lake Ida. The lake has an elevation above the sea of a trifle over 1400 feet. Its shores in many places are bold and rise abruptly 20 to 40 feet above the water. They are covered with forests except in a few places. The leaf hills to the north, dun and hazy in the distance, are seen from centre of the lake. There are large areas of the lake which are shallow and the bottom is covered with a dense growth of aquatic plants. Although a number of soundings were taken in different parts of the lake, only one place of considerable depth was found where the line showed 80 feet of water; this was a little south of the centre. Other parts showed 30 to 50 feet, but the majority of soundings gave 14 to 25 feet. Owing to the amount of vegetation growing, the water is not as free from foreign matter as some lakes. It is, however, clear, sparkling with no tinge of yellow. There are some fine springs on the shores of this lake, and some stately forest trees, sugar maple, elm and basswood are flourishing. The temperature of the water on the 10th day of August was 75° F. on the surface, 73.5° F. at the bottom. Air 80° F.

Lake Ida.

Next in size and order is Lake Ida. It is four and a half miles long and one to one and a half miles wide. It has an area of about five square miles. It lies east of the central drift ridge, which divides the waters of the county. The surrounding country is massive rolling drift, and on the eastern side is well timbered. The water is very pure and crystalline. The shores are strewn with pebbles and small sub-angular boulders. There are very few reeds and rushes. I found the temperature of the water on the 16th of August to be 73° F., air 81° F. The inlet of Lake Ida is at the northern end, where it receives the surplus water of Lake Miltona. The outlet is at the southeast corner, at Alden's flour and saw mills, whence it flows south.

Lake Latoka.

This charming little lake is only two miles from Alexandria. It is about one and a half miles long, and half a mile wide. It lies in a deep and quite uniform basin. It has an average depth of

fifty feet, the greatest being eighty feet. The bluffs around the north end at the outlet are from two to thirty feet high. The soil is sand and gravel, including some boulders. The water is remarkably pure and of a deep bottle green color. The surrounding country is covered with forest.

Lake Cowdrey,

A few rods north of Latoka is smaller in area but a very pretty lake. Here the surplus water from some twelve or fourteen other lakes combine and send a deep strong current north to Lake Darling.

Lake Darling.

A sheet of water two miles long and a mile wide, surrounded by forests of stately trees, dry and bold shores, divided by a bar near the northern end into two basins, almost two lakes, this is Lake Darling. The inlet at the southern extremity is a deep, strong current pouring continually into this lake the surplus waters of a dozen others. The depth varies from sixteen to fifty feet. The water is clear and pure.

Lake Victoria receives the drainage from half a dozen smaller lakes at the south. There are two arms, an eastern and western, both have inlets and combine to form the main body of the lake. The western arm is much the larger. In this basin the great mass of the water lies. Its depth, near the center, varies from 40 to 50 feet. The east arm is 30 to 40 feet deep. Near the outlet the water becomes shallow and reeds are numerous. In the center of the lower part of the lake the depths vary from 22 to 38. The water is not very pure; it contains a considerable amount of decaying vegetable matter, brought down from swamps and shallow lakes above. The shores of the Victoria are generally high and wooded. The banks where exposed, are clay. A very short outlet, crossed by the St. P. M. & M. R. R. brings us to the next link in the chain.

Lake Geneva is nearly two miles long and half a mile wide. Its waters are clearer than those of Victoria. In some parts it is also considerable deeper. Soundings varying from 30 to 60 feet were made in the south half of the lake. There is clay in the surrounding bluffs which arise 10-20 feet above the water. The R. R. has made a long, high "fill" at the inlet. In consequence of these

facts the water holds in suspension considerable earthy matter, giving it at times a faint yellowish tinge.

One of the charms of this chain of lake and the country adjacent is the presence of fine, large, forest trees which the ravages of the "woodman" have not laid low. For this reason the shores of these lakes are particularly attractive as places of resort in summer and are capable of such improvement at small expense, as would make them delightful places of residence.

Lake Le Homme Dieu.

This lake has a quite irregular shape and lies in two distinct depressions of unequal depth. The long point that runs out from the west side is continued under water by a bar extending more than half way across the lake. In the southern basin, not far from the inlet, the water is from 60 to 75 feet deep. In various parts of this basin depths varying from 25 to 57 feet were found. The lower basin at the north end of the lake is larger and includes a deep bay on the west side, but on the whole this portion of the lake is shallower than the other.

As a whole it is one of the mose beautiful sheets of water in Minnesota. The shores are moderately high and well-wooded. It is separated only by a narrow bar from Lake Carlos. The water is clear and pure. In this respect there is a gradual improvement as we proceed down the chain. Geneva is purer than Victoria. Le Homme Dieu is purer than Geneva, and Carlos is the purest of them all. Temperature of Lake Le Homme Dieu July 13th was 78° F. air 84°.

Lake Carlos

is the gem of this group of lakes. It is the last and lowest of the series. It is the immediate source of Long Prairie river, which forms its outlet at the northeast corner. It has two inlets, one from Lake Darling at the southern extremity, and the other from Lake L'Homme-Dieu. It thus receives the surplus waters of all the other lakes north and south and the drainage of six townships. The lake in some places is 150 feet deep, and there is a channel averaging about 50 feet deep, extending the entire length of the lake. The deepest area is not far from the L'Homme-Dieu inlet. There are shallow areas where the water is only 5 to 10 feet deep, further

down the lake. It is about five miles long and a mile wide. The water is almost perfectly pure, of a deep bottle-green color. The color however varies with the sky and weather, and is sometimes a deep indigo and sometimes a light delicate blue. In this lake, as in many others which have been explored with the sounding line and other appliances for discovering what lies at the bottom, it was found that there are, under the level surface of the water, a variety of hill and dale, plateaus, ravines, abrupt declivities and gradual slopes very similar to the irregularities of the country around. Vegetation too flourishes beneath the waves as vigorously as on the main land, while the waters are thronged with fish of many species and of delicious flavor.

There are many indications about the shores of these lakes of former higher levels of water. There are old beaches and half-obscured terraces which show that the lakes were connected at no very remote date. The whole of "Alexandria prairie," which lies between the two chains of lakes, is modified drift. The gravels, sands and clays are finely stratified and record the fact that at the close of the ice age some ancient river with gentle current flowed here, rearranging and depositing in their present positions the materials which the glacier had brought down.

Lake Osakis.

On the eastern boundary of Douglas county, but lying chiefly in Todd county, is Lake Osakis. It is about seven miles long. The southern part is a mile and a half to two miles wide. The northern part is narrow and deep. The depths at the upper end of the lake varied from 40 to 70 feet. Near Battle point 50 feet of water were found repeatedly. In the broader part of the lake there are large areas of shallow water, varying from five to fifteen feet, the average depth being about twenty-five feet. Around the southern part of the lake. the prairie slopes down gradually to the water's edge. Some of the shores are low and wet. At other points they are from ten to twenty feet above the water. The water varies in purity. In the deep parts at the north end it was quite pure. In shallower places and where the mud stirs the whole volume to the bottom, it has the yellowish hue characteristic of the more alkaline lakes.

Lake Oscar.

Among the hills in the southwestern part of the county are a multitude of small lakes, the largest of which is Lake Oscar. The surrounding country is rolling, and there are some abrupt declivities and massive hills of drift, whose summits are from 50 to 150 feet above the lakes. There is a fringe of oaks about the lake, and a forest on the northeast stretches away to Alexandria and beyond. Toward the west and south lies a prairie country. The outlet of Lake Oscar, in high water, is into the Chippewa river. Its only tributaries are other and smaller lakes. The basin is subdivided by various points and bars. The outlet is very irregular. This interlocking of land and water gives the most charming scenery. The shores are bold, being in several places 30 to 40 feet above the water. The lake is about 30 feet deep in its largest basin, growing shallower, of course, about the shore's points. The temperature of water 75° F., and the air 58° F. to 80° F.

In the extreme northwestern part of the county is Lake Christina, which has an area of about six square miles, but is very shallow. The water is a decidedly yellow and muddy. It is full of reeds and rushes. Its shallow depths and the rills and runlets pouring down from clay deposits keep it looking very much like Missouri river water. It is rather exceptional in this respect among the lakes of this region. Pelican lake, which joins it on the southwest, is clear, although the lake also is shallow and the water clouded and alkaline. Neither of these lakes are attractive, although to one passing by on the railroad, which runs between them, they may appear so.

Otter Tail is the banner county of the State for lakes. It is said by those who have given their minds to counting them, that there are 430 lakes in the county. This number of lakes is not represented on any maps that I have seen. Still the number is sufficiently large, as any one will admit who has traveled over the county.

The relation of these lakes to the great moraine, that gigantic relic of the glacial age, which Mr. Upham has traced through the State, is both intimate and interesting. A glance at the map shows that the lakes occupy the central townships of the county. The eastern and western tiers of towns have none, or a few small lakes. This distribution of the lakes corresponds with the position and bearing of the moraines. Entering the county at the

north, in the town of Hobart, the general direction of the drift deposit is southeast until, in the vicinity of Fergus Falls, it tends southeast and east, and then swings northeast, where its greatest development is seen in the "leaf nets," as they are popularly called. This hilly area is gemmed with lakes. Every depression in the rough and rolling ground holds a mirror to the sky and clouds. They are of all sizes, shapes and depths. Some have outlets, the largest ones especially; others have none, except in very high water; others have no outlet whatever at any time. Of some the water is whitish or clouded, holding in solution mineral substances derived from the clays and gravels of the shores. Others are apparently perfectly pure, colorless and sparkling.

It is manifestly impossible to examine all these lakes in a single season. Only those were selected which are typical or in some respects remarkable. Of the smaller lakes Lake Sewell in St. Olaf is as good a representative as any other.

Lake Sewell.

It is about two miles long and half a mile wide. The shores are not very high and generally slope gently to the water's edge. There is a fringe of trees and shrubs of the common species about the lake, but most of the country is massive rolling prairie with frequent lakelets and sloughs.

It was ascertained by sounding that the lake is 35 to 40 feet deep in the central or deeper parts. As there is no erosion of the banks the waters are quite pure and free from mineral substances. The bottom or floor of the lake is clay covered by gravel stones and the beaches are deposits of sand and pebbles.

In all these smaller lakes the same feature are repeated over and over. A large number of these lakes have no visible outlet except in very high water. The channel—of the outlet—is grass grown and dry, except a weeks or perhaps a few days in the year.

Lake Clitherall.

This beautiful sheet of water is nearly four miles long and one mile wide. It has a deep bay extending toward the south, a distance of two miles. The south shore is densely wooded and presents to the observer on the north side a very picturesque appearance. The shores at various points are bold and high, and there is a fringe of forest trees on the north side also, where the village

of Clitherall, a Mormon settlement, stands. There are one or two bars extending nearly across the lake so that the water does not lie in one continuous basin. Our soundings gave for the east part of the lake a depth varying from 15 to 44 feet, and for the west part from 10 to 32 feet. The water is clear and had at the date of our visit, August 1, a temperature of 77° F. This lake lies at an elevation of 1332 feet above the sea. Its outlet is at the northwest side and discharges into West Battle Lake.

West Battle Lake.

This lake lies in two basins. The western half is nearly twice as wide as the eastern. The shores are in some places bold and abrupt, rising 40 to 60 feet above the lake. At other points the prairie slopes gently down to the water. There is not much forest. Nearly all the surrounding country, especially at the western extremity is cultivated prairie. The lake is over six miles long. The western part is about two miles wide; the eastern division about one mile wide. A high, wooded hill or promontory on the north side marks the line of division. Our soundings were made in the western part of the lake. The bottom of the lake is uneven. There are ridges and shallow places out some distance from the shore. We found repeatedly about 50 feet of water. The depths vary rapidly within short distances. The mass of the drift about these lakes is siliceous; some of these bluffs are almost pure sand; these crumble under the action of frost and weather and are distributed over the bottom of the lake by the waves. All the beaches are sand and pebbles. There is very little vegetation in the waters of this lake.

Owing to the purity of its water and the inequalities of depth, this lake presents the most rapid and beautiful play of colors. There is not a more charming or attractive spot in Minnesota than the vicinity of Battle lakes. They lie in midst of the famous Park Region, groves, lakes, cultivated farms, unoccupied woodland conspire to give variety and beauty to the scenery.

West Battle lake has two outlets, one from Lake Clitherall, the other from East Battle lake. Its outlet is on the north side and after passing through several smaller lakes, discharges into Otter Tail lake at Balmoral mills.

East Battle Lake.

The country around East Battle lake is very broken and hilly. The Leaf mountains lie a few miles to the southwest. Several small streams convey the drainage of these hills to the lakes. The basin of this lake is very irregular. There are numerous promontories, points and bays. The depth varies from twenty to forty feet. Only a small part of the lake was sounded, as no safe boat could be obtained. The hills and shores of the lake are covered with trees and shrubs. The outlet into West Battle lake has evidently run much wider and larger than now. It flows through a low meadow or swamp, and is still a considerable stream about ten feet wides.

On a high bluff between these lakes are a series of mounds which have the appearance of having been a fortified camp. Some of them are long and four to six feet wide. Others are nearly round. The largest round mound is about six feet high, 25 feet across the top, and 130 feet in circumference. There are about a dozen of the mounds together.

Otter Tail Lake.

This is the largest body of water in the county. Indeed in this whole lake district which embraces parts of Becker, Otter Tail, Douglass, Pope and Kandiyohi counties, there is no lake which can compare with this in size. It is about ten miles long and three miles wide. Its longest direction is from northeast to southwest. It has three inlets, one from the south and two from the north. The largest of these is known as Otter Tail creek and is the outlet of Rush lake. A large inlet also flows down from Dead lake on the north. At Balmoral mills on the south side it receives the surplus waters of the Battle lake chain. The soundings were in the southern central part of the lake going out from Balmoral mills. For distance of half a mile or more from the shore the water is quite shallow, only six to eighteen feet of water. Toward the centre of the lake it deepens to forty, fifty and sixty feet. This deeper area was followed for some distance toward the head of the lake, when the high wind prevented further measurements. The temperature of the water on the 30th of July was 74° F., air 78° F. Prof. Owen took the temperature of this lake on the 18th of June, and found it 65° F., air 64° F. The water is not perfectly pure. It has the yellowish or clouded color characteris-

tic of shallow lakes with clay bottoms and shores. The soil on the southern side is sandy; at other points, however, the clay is exposed and the feeders are colored by the clay deposits through which they flow.

The lake is without islands or any bold and prominent indentations of the shore. It is therefore less picturesque and attractive than some other and smaller sheets of water. The outlet of Otter Tail lake is the Red River of the North, formerly known as the Otter Tail river. It is here 30 to 40 feet wide.

The southeastern shores of the lake are fringed with trees. Further north the prairie comes to the water's edge. On the western and northern shores are forests, interspersed with some fertile prairies or openings.

Dead Lake.

Northwest of Otter Tail, are several lakes of irregular shape, surrounded by forests and morainic hills and deposits of clay. Approaching Dead lake from the south, near its outlet, a fine growth of native forest trees is encountered. The sugar maple, basswood, oak, elm, ash and ironwood are especially noticeable. The lake itself is divided by bars and points, into several distinct basins and bays. The bottom is as irregular in shape as the shore line. The main body of the lake is shallow. Our soundings gave from 10 to 25 feet of water. There is a good growth of reeds, wild rice and other vegetation in the lake. There are a few small islands. The shores are full of boulders, both granite and limestone rock. It is indeed a lake of the woods, difficult of access, but wild and picturesque, a favorite haunt of water foul and other game. The principal tributary is a small stream which connects it with Star lake.

The country to the east is rough and hilly. One hill near the outlet rises abruptly 98 feet above the water. On the north side the shores slope more gently and smoothly to the water. Further still to the northwest is a chain of very beautiful lakes, lying on the west side of the great moraine and tributary to Pelican river. These are Lakes Lida and Lizzie and Pelican lake. Between these lakes and on the east side, there is a fine forest of hard-wood trees, of species already mentioned. On the west side the prairie stretches away toward the Red river. All the surrounding country is rolling and uneven. The largest of the three lakes is Lake Lida. It is about seven miles long and two miles wide. A narrower arm, about

one mile wide, extends south from the main body of the lake for two miles. The eastern shore is wooded and hilly. The western shore is more level and the forest soon gives place to the prairie.

Between Lakes Lida and Lizzie, which formerly constituted one lake, there are several old beaches, now covered with forest trees, indicating that the former level of the lake was from seven to ten feet higher than it is at present.

The outlet of Lake Lida is at the north end. It is a strong current of water, three feet deep and fourteen feet wide. The temperature of the lake on the 13th of September was 63° F., air 70°. The lake varies in depth from 10 to 40 feet. About the shores it is shallow. The water is very pure and clear. There are several fine springs about the shores. There are, in the vicinity of these lakes, a number of cranberry marshes from which, without any effort at cultivation, a good many bushels of cranberries are gathered every year.

Lake Lizzie.

The southern part is quite shallow and narrow and filled with reeds and rushes for some distance out from the shore. The northern part is broader and deeper. The eastern shore is covered by forest, while on the western side the prairie, in some places, comes nearly to the lake. The country is massively rolling, and as a general rule sandy, but there are also large deposits of clay. One well, on the west side of this lake, was dug 78 feet, through sand and gravel, and another, a quarter of a mile away, 60 feet, through clay. The outlet of Lake Lizzie is the Pelican river, at this point 40 feet wide and 3 to 4 feet deep. About a mile west of the outlet the river spreads out into Prairie lake, which has an area of about two square miles. The quality and temperature of the water did not differ materially from that of Lake Lida. There are two small islands of about two acres each in this lake.

Pelican Lake.

This is a very picturesque and beautiful lake with high bold, high shores wooded on the eastern and prairie at the western end The water is very pure and sparkling. The depth varies from 8 to 40 feet. On the south side are some excellent springs. The ex posures of soil on lake shores are sandy; no clay was seen. The bottom is uery uneven, especially in the south arm, which is some-

times called Fish lake. From this arm the outlet discharges its waters into Lake Lizzie.

This country is not thickly settled. A large amount of land is still unclaimed. The tide of emigration has swept into the more fertile and better advertised Red River Valley.

These three lakes with seven or eight others in Becker county, which lie above them, constitute the Pelican chain and are a grand reservoir of water feeding that river with perpetually fresh supplies.

IX.

REPORT OF PROGRESS

IN EXPLORATION OF THE

GLACIAL DRIFT AND ITS TERMINAL MORAINES.

BY WARREN UPHAM.

The work of exploration during 1880, of which the following is a partial report, was begun on the 19th day of April and closed on the 3d of December, the distance traveled by horse and wagon in this time being about 4,500 miles. Excepting a trip of six weeks between the St. Croix and Mississippi rivers and through the south part of Stearns county, to a north limit in Pine, Kanabec, Mille Lacs and Crow Wing counties, the remainder of this year was spent in the examination of the region lying south of the Minnesota river, to an east limit in Dakota, Rice, Steele and Freeborn counties. These districts have been explored in respect to their topography, economic geology, glacial drift, and their few exposures of the older rocks. Information has also been gathered concerning the flora, areas of forest and prairie, and water-powers.

New observations of rocks underlying the drift include a Cretaceous sandstone seen in Altavista, the northeast township of Lincoln county, at a few points in northwestern Lyon county, and at one place in Martin county; an area of the red Potsdam quartzyte, extending 22 miles from east to west in northern Cottonwood county, and reaching into the edge of Adrian, the northwest township of Watonwan county, and of Stately, the southwest township of Brown county; and several outcrops of granite, gneiss and schists, occurring 10 to 20 miles southwest of the Minnesota river, in Yellow Medicine and Redwood counties. Records have been

secured of the strata passed through by deep wells at Hastings, Mendota, Owatonna and Mankato, the last being 2,204 feet deep, not penetrating the Potsdam formation; and of several wells which go through the drift and a small depth into the bed-rock, in Waseca, Freeborn and Faribault counties, which have no outcrops of rocks on the surface.

Additions have also been made to our knowledge of the Lower Silurian rocks exposed on the Blue Earth river and its tributaries; of the Potsdam quartzyte in Pipestone and Rock counties, and in Minnehaha county, lying at the west side of the latter, in Dakota; of the St. Croix sandstone and copper-bearing rocks at the east side of the State; and of the outcrops of syenite, granite and gneiss in Benton and Stearns counties; most of which Professor Winchell has examined and in part described in the earlier reports of this survey.

Four counties, namely, Steele, Freeborn, Pipestone and Rock, which had been previously reported on, were again explored with special reference to the glacial drift; and notes were gathered for the general description of the following seventeen counties: Chisago, Isanti, Waseca, Faribault, Blue Earth, Brown, Watonwan, Martin, Jackson, Cottonwood, Redwood, Lyon, Murray, Nobles, Lincoln, Yellow Medicine and Lac qui Parle.

Nine of these twenty-one counties have no exposure of the bed-rocks, and the greater part of each of the others is without such outcrops. Our observations therefore relate chiefly to the superficial deposits of drift, and of these the portions which have added most to our knowledge of the succession of events in geological history, are the ranges of drift hills denominated terminal moraines. A remarkable formation of this class has been traced in an irregular, looped course through Minnesota. Our exploration has also been extended southward into Iowa, in order to learn whether the two parts of this series which reach beyond the south line of the State are connected by a continuous, curving belt, being thus shown to have been formed at the same epoch. The present report treats principally of this formation, which is believed to have been accumulated at the margin of a vast ice-sheet that overspread the northern half of North America in the latest completed period of geological time, as the Antarctic continent and the interior of Greenland are now buried beneath ice thousands of feet deep.

THE GLACIAL DRIFT.

The region covered by this exploration, like that lying next to the north, traversed by the writer in 1879, and described in that year's report, is thickly overspread by the glacial drift, with very rare exposures of the bed-rocks, except in deeply-excavated valleys, as of the Minnesota river. Along this river the drift-sheet is from 100 to 200 feet thick, and it extends with a similar depth over the western two-thirds of Minnesota and over large areas in Michigan, Wisconsin, Iowa, Dakota and the region farther northwest drained by the Assiniboine and Saskatchewan rivers.

Within the portion of Minnesota explored during these two years, the material of this thick sheet of drift nearly everywhere is the unmodified deposit of the ice-sheet, composed of clay, sand, gravel and boulders, mixed indiscriminately in an unstratified mass. Very finely pulverized rock, forming a stiff, compact, unctuous clay, is its principal ingredient, whether at great depths or at the surface. This formation is denominated till, boulder-clay or hardpan. Layers of stratified gravel and sand are enclosed in this deposit, and are the source of the sudden inflow and rise of water frequently found in digging wells.

The till upon the western two-thirds of this State has a dark blueish color, except in its upper portion, which is yellowish to a depth that varies from 5 to 50 feet, but is most commonly between 15 and 30 feet. This difference of color is due to the influence of air and water upon the iron contained in this deposit, changing it in the upper part of the till from the protoxide state to hydrated sesquioxide. Another important difference in this till is that its upper portion is more commonly softer and easily dug, while below there is a sudden change to a hard and compact deposit, which must be picked, and is often three times as expensive for excavating. There is frequently a thin layer of sand or gravel between these kinds of till, which have their division line at a depth that varies from 5 to 30 or very rarely 40 feet. Owing to the more compact and impervious character of the lower till, the change to a yellow color is usually limited to the upper till. The probable cause of this difference in hardness was the pressure of the vast weight of the ice-sheet upon the lower till, while the upper till was contained in the ice and dropped loosely at its melting.

The motion of the ice-sheet upon this part of the State was from the north to the south or southeast, as is shown by the direction in which the boulders of the drift in this region have been

carried, and by the courses of glacial striæ, or the scratches and grooves worn on the surface of the bed-rock by stones and boulders pushed along in the ice. Most of the limestone boulders and blocks that occur frequently in the drift throughout western Minnesota, are like limestone strata which are found in Manitoba; these are their nearest outcrops, but they may underlie the drift in portions of western and northwestern Minnesota. The boulders of granite, syenite, gneiss and schist, which abound here and southward through Iowa to the limit of the drift in Missouri, have been derived from the Laurentian highlands north of Lake Superior, and from the broad area of these rocks which reaches southwestward across Minnesota to the Coteau des Prairies. The masses of copper that are found rarely in the drift of southern Minnesota and Iowa, west of the driftless area, were almost certainly brought from the vicinity of Lake Superior, and demonstrate that the current of the ice-sheet by which they were carried was first southwest and then south. Outcrops of the red Potsdam quartzyte are found at various places from New Ulm west-southwest to the James river. North from this district the drift contains no boulders of this rock, but southward they are common; and though this formation extends into Iowa only at its northwest corner, its fragments have been spread by the ice-current through the till of that State west of the Des Moines river and its east branch, but not farther east.

Everywhere a great part of the material of the drift has been supplied by the rocks which form the region adjoining, in the direction from which the ice-current came. Boulders and pebbles of any peculiar kind of rock which can be referred to a particular source, are most abundant within the first ten or twenty miles from their parent ledges; and they diminish in numbers and average size as the distance from their source increases. While the drift is always made up largely in this manner from the formations of its vicinity, some parts of its mass, including both fine detritus and boulders, were gathered at great distances. Fragments of Laurentian rocks in the till south and west of Minnesota, appear to have been carried by the ice-sheet from 500 to 700 miles.

Upon the district lying between the St. Croix and Mississippi rivers, along the St. Louis river to its bend in T. 51, R. 20, and on both sides of Lake Superior, the till is reddish, its color sometimes being nearly like that of red brick. Generally, also, the stratified gravel, sand and clay of this region are similarly colored. Eastward these red drift deposits extend through northern Wiscon-

sin and the upper peninsula of Michigan and southward into central and southern Wisconsin at the east side of the driftless area. The color of this drift is caused, as Col. Charles Whittlesey has suggested*, by the presence of a considerable portion of hematite, the anhydrous sesquioxide of iron, derived from the large areas north and south of Lake Superior, which are occupied by rocks bearing this ore. Boulders within this region have been transported from the northeast to the southwest and south; and the courses of glacial striæ are in these directions. The red till in eastern Minnesota was thus deposited by a part of the ice-sheet which came from Lake Superior, and extended southwestward to a limit that coincides approximately with the course of the Mississippi from Brainerd to Hastings; while in other parts of the State, blue till, colored yellowish near the surface, was formed by a part of the ice-sheet which moved from the northwest and north.

The terminal moraines which form the principal subject of this report, show that the southern portion of the continental ice-sheet was divided into great lobes, each having a central current in the direction of its longer axis, with diverging currents bending from this and becoming perpendicular to its border. The red and blue tills were the deposits of two such ice-lobes which overspread Minnesota from the northeast and northwest. During the most severe epoch of the ice age, before that in which the terminal moraines of Minnesota were accumulated, an ice-sheet reached much farther south, to a limit 20 to 100 miles southwest and south of the Missouri river and within a less distance north of the Ohio river. Portions of this glacial sheet, moving from the northeast, north, and northwest, enclosed an area about 150 miles long from north to south and 100 miles wide, lying principally in southwestern Wisconsin, but extending into Illinois, Iowa and southeastern Minnesota, which was not covered by ice and has no till nor striæ. This driftless area has a less average height than the adjoining regions which were glaciated. Climatic conditions of greater snowfall and lower temperature seem to have produced the ice-fields, which lay at each side of this tract and were confluent farther south.† The wedge-shaped area of highland that reaches southwest from Keweenaw Point, at the south side of Lake Superior, and the depressions of Lake Michigan and Lake Superior, have also been regarded as the causes of this division of the continental glacier.‡

*On the Fresh-water Glacial Drift of the Northwestern States, in Smithsonian Contributions, 1864, pp. 8 and 9.

†Prof. J. D. Dana, in Am. Jour. Sci., April, 1878; Third series, vol. xv., pp. 250—255

‡Prof. N. H. Winchell, in fifth An. Rep. on Geol. Sur. of Minn., 1876, pp. 36 and 37; and Prof. R. D. Irving, in Geology of Wisconsin, vol. ii, 1877.

The occurrence of this driftless tract shows that the ice-sheet which reaches farthest south was divided in portions that moved independently, with diverging and converging currents; and that in respect to the districts over which they extended, these glacial movements corresponded to the lobes that formed the southern part of the ice-sheet at the later time when the looped moraines of Wisconsin, Minnesota, Iowa and Dakota were pushed out at its margin.

The red and blue tills were being deposited during each of these epochs, and where the blue overlaps the red, as in Hennepin county, both may have been formed while the ice-sheet reached to its farthest limit, covering all this region excepting the driftless area at the southeast. Differences in climate, intervening between the early and late portions of this epoch, would then appear to have extended the ice-fields on the west, pushing back the glacial current which came from the northeast, by which the red drift was brought. The later ice-sheet which formed our terminal moraines was here divided into lobes that similarly advanced from the northwest and northeast, approaching near each other at the west and east borders of Minneapolis, and meeting in northern Dakota county, a few miles farther south. At this time the ice-fields moving from the northwest extended here at least several miles eastward over the edge of the earlier sheet of red till; and it may be found, by more full and detailed study of the terminal moraines through this part of the State, that all the blue till overlying the edge of the red till was brought during this last glacial epoch, in which a new deposit of red drift was also spread over eastern Minnesota to the moraine that was then formed by the ice-fields moving from the northeast.

TERMINAL MORAINES.

Within the last five years a very important contribution to our knowledge of the ice age has been made in the discovery of distinct series of drift-hills which appear to have been accumulated at the margin of the continental ice-sheet, corresponding to the terminal moraines of alpine glaciers. The most notable of these deposits which have been found at the extreme limit of glacial action is the series of drift-hills which has been explored by Professors Cook and Smock across northern New Jersey,* and by the writer through the entire length of Long Island, and on Block

*Annual Report of the State Geologist for the year 1877, pp. 9-22, with map.

Island, Martha's Vineyard and Nantucket.* Five to thirty miles north of this line a second morainic series extends from Port Jefferson eastward along the north shore of Long Island, through Plum and Fisher's islands, along the south shore of Rhode Island, forms the chain of the Elizabeth islands, and reaches along Cape Cod to its east shore.† In Pennsylvania the continuation of these moraines westward is now being traced by the second geological survey of that State. The extreme limit of the glacial drift has not yet been found to be marked by extraordinary deposits in the interior of the United States; but a most notable series of terminal moraines, north of this line and probably contemporaneous with that of Cape Cod, is found, as shown by Professor Chamberlin,‡ stretching across Ohio, and represented in northern Indiana, southern Michigan, northeastern Illinois, and very remarkably in the Kettle Moraine of Wisconsin.§

Plate VI., at the end of this report, shows the course of this formation from central Wisconsin to the Coteau du Missouri, the direction of glacial movements, and the driftless area. In Wisconsin this follows the descriptions and maps of the geological survey by Professors Chamberlin and Irving. The terminal moraine marking the limit of the ice-fields which pushed southwestward from Lake Superior in our last glacial epoch, continuous with the Kettle Moraine of Wisconsin, enters Minnesota at the west side of St. Croix lake, is crossed twice by the Mississippi, 7 to 10 miles south of St. Paul, and again between this city and Fort Snelling, and reaches thence northward between Saint Paul and Minneapolis, to the hills of Manomin and Mound View. Its course thence north and northwest to the Leaf hills has not yet been fully explored. The plan for the field-work of 1881 covers this district and the valley of the Red river, which was occupied by the glacial Lake Agassiz during the recession of the ice-sheet, as partially described in my preliminary report for 1879. That report also described this terminal moraine in its course from the Leaf hills in southern Otter Tail county, southward through Douglas and Pope counties, eastward through Kandiyohi, Meeker and Wright counties, and again southward through Hennepin, Scott, Rice and Le Sueur counties; showing that this series of drift hills, extending 250 miles, if we include also the medial moraine that continues 50 miles north from the Leaf hills to White Earth Agency, was accu-

American Journal of Science and Arts, Aug. and Sept., 1879; Third series, vol. xviii.
†*American Naturalist*, Aug. and Sept., 1879; vol. xiii.
‡"On the Extent and Significance of the Wisconsin Kettle Moraine," in *Transactions of the Wisconsin Academy of Science*, 1878, with maps.
§*Geology of Wisconsin*, vol. ii., 1877; and vol. iii., 1880.

mulated at the northeast side of a prolonged lobe of the ice-sheet which reached from the Leaf hills southward into Iowa, having its west side at the Coteau des Prairies.

The exploration of this terminal moraine in 1880, as detailed in the following pages, continues from the limit of the preceding year, at the south side of Rice and Le Sueur counties, through Steele, Waseca and Freeborn counties, and into Iowa to Mineral Ridge in northern Boone county, a distance southward of 140 miles; and reaches along the west side of the U-shaped course of this formation from the north part of Guthrie county, in Iowa, to Spirit lake and northeastern Osceola county at the north line of the State, across southwestern Minnesota upon the Coteau des Prairies, and into Dakota to t. 119, r. 50, in Grant county, 20 miles southwest of Big Stone lake, a distance of 260 miles; making, upon both sides of this morainic loop, a total of 400 miles. The moraine described by Dr. C. A. White,* in Hancock and Kossuth counties, Iowa, at first supposed to mark the southern end of the ice-lobe at the border of which this curved series of hilly and knolly drift was accumulated, appears instead to be a medial moraine, connected with the east side of this loop which reaches southward beyond the center of Iowa.

Beyond the western limit of this exploration in Dakota, our map is based on the various authorities which are cited in the description of the apparently medial moraine which reaches from the Head of the Coteau des Prairies, west of Lake Traverse, 275 miles northwesterly to the Devil's lake and Turtle mountain, and of the looped terminal moraine which extends south at the west side of the Big Sioux river, then west across the lower part of the James river and northwest upon the Coteau du Missouri. The features of these moraines upon our national boundary at Turtle mountain and at the northwest corner of Dakota, the latter being outside the area of this map, are from Mr. George M. Dawson, of the Geological Survey of Canada. Still farther north the continuation of the moraine of the Coteau du Missouri is briefly described from the writings of the same author, and from the report of Prof. H. Y. Hind on explorations in the region of the Assiniboine and the South and North Saskatchewan rivers.

Professor Hind also gives an account of channels that have been deeply excavated in the glacial drift, and have since become partially filled, so that the present streams flow through long lakes. The most remarkable of these channels or valleys is that which

*Geology of Iowa, 1870, vol. i., pp. 98 and 99.

reaches from the elbow of the South Saskatchewan to the Assiniboine river, being occupied by the River that Turns and the Qu'Appelle or Calling river. Gen. G. K. Warren has called attention* to the similarity of these valleys with that which was the outlet of Lake Agassiz and now contains Lakes Traverse and Big Stone and the Minnesota river. The formation of the valleys described by Professor Hind may be well referred to causes like that which is believed by the writer to have formed the Minnesota valley, namely, the existence of lakes within basins which slope to the north or northeast, held by the barrier of the ice-sheet during its recession northward at the close of the glacial period, and outflowing over the present lines of watershed until the departure of the ice permitted drainage to take place as now. By applying this explanation to the ancient channels which evidently have carried large rivers southeastward over the watersheds of the basins of the South Saskatchewan and Souris rivers, we are enabled to note the successive steps by which the ice-sheet retreated. After it had been melted away upon Dakota and nearly to the north line of Minnesota, it appears to have re-advanced, forming the apparently contemporaneous terminal moraines of the Blue hills and the Mesabi range, the former reaching 75 miles east from the lower part of the Souris or Mouse river, and the latter extending through northern Minnesota eastward from the sources of the Mississippi. Lake Agassiz filled the depression which lies between these morainic series, concealing the coarser drift beneath its stratified sand and clay.

The material of the terminal and medial moraines which have been explored during 1879 and 1880, extending 650 miles, is nearly everywhere till, or chiefly till with scanty deposits of modified drift. The latter consists of obliquely and irregularly stratified gravel and sand, the gravel often being very coarse, with pebbles and rounded stones of all sizes up to a foot or more in diameter. It either occurs enclosed in the till, forming beds and masses of variable shapes from a few inches to several feet in thickness, or rarely it is spread upon the surface and forms knolls and ridges. No considerable area or large portion of the entire mass of this formation is found to consist of this modified drift, assorted and deposited in layers by currents of water, within this region; but n some parts of the course of these series of terminal drift deposits, as notably on Long Island, they are made up wholly, so far as can be seen on the surface and in excavations, of such stratified

*An Essay concerning Important Physical Features exhibited in the Valley of the Minnesota River and upon their Signification. Engr. Dept., U. S. Army: 1874.

beds. The till of the moraines differs very noticeably from the more level areas of till which generally lie at each side; in that the former has many more boulders, and a much larger intermixture of gravel and sand than the latter. On an average, probably twenty times as many rock-fragments, both large and small, occur in the morainic hills and knolls as on the smoother tracts, and sometimes the ratio is a hundredfold. The smaller pebbles and stones have angular and unworn forms, or more frequently are rounded, probably by water-wearing before the glacial period, or show planed and striated surfaces, due to grinding under the moving ice-sheet. The large boulders are mostly less than five feet, but rarely are ten feet or more in diameter. In form they are subangular and of irregular shape, rarely showing any distinctly water-worn or glaciated surface.

In contour these deposits are very uneven, consisting usually of many hillocks, mounds and ridges of rough outlines and broken slopes with enclosed hollows, which are sometimes nearly round, but more generally have some irregular form. often holding sloughs and lakelets. The only indication of system appears in the frequently noticeable trends of the elevations and depressions in a direction approximately parallel with the course of the series. It should be added that the ridges which occur as part of this formation differ from the ridges of interbedded gravel and sand called kames, in their material, which is boulder-clay or till; in their trend, at right angles with the course in which the ice moved, while series of kames extend nearly in the direction taken by glacial currents; and in their length, single ridges of the moraines being only from a few rods to a quarter of a mile or very rarely perhaps a half mile long, while a single ridge in a series of kames is generally longer, and is sometimes distinctly traceable ten or twenty miles. In this State, however, prolonged kames, comparable with those of Sweden and Scotland, and those recently described in Maine by Prof. George H. Stone, in Massachusetts by Rev. G. F. Wright, and in New Hampshire by the writer, have not been found. Besides the very rough, knolly and ridgy portions of moraines, in some other districts within the extent of these explorations they have only a prominently rolling surface, moulded in smooth swells of moderately steep and gracefully curved slopes, also trending, wherever any uniformity is noticeable in the direction of the series. Neither these nor any other drift accumulations observed in this region have the smoothly oval contour of the remarkable lenticular hills of till described by Prof. C. H.

Hitchcock and other writers in New England; and the trends of these two classes of drift hills differ ninety degrees in their relation to the course of motion of the ice-sheet.

The height of the moraine elevation above the intervening hollows is generally from 25 to 75 or 100 feet. The only district where they are higher for any considerable part of the series is the Leaf hills, which through a distance of 20 miles rise from 100 to 350 feet above the adjoining country. Upon the Coteau of the Prairies and the Coteau of the Missouri moraines lie on areas of highland, to the altitude of which they appear to add 75 or 100 and rarely 150 or 200 feet.

For agriculture the value of these terminal and medial moraines is much less than that of the gently undulating till which generally covers other parts of this region. Among the hills of this formation, however, are found considerable areas which have a smooth surface, nearly free from boulders, and possess a highly productive soil. In other districts the entire morainic belt is in smooth swells, being all good farming land. The portions which are too knolly and stony for desirable cultivation afford excellent pasturage; for the greater part of this formation like the region through which it extends, is prairie, or natural grass lands, without tree or bush. Its rough and hilly belts occupy at the most, only a width of a few miles, and nowhere merit the description which Owen, usually a very accurate observer, gave of them in northern Iowa, where he reported that "a desolate, barren, knobby country. .... prevails for about three quarters of a degree of latitude, and between three and four degrees of longitude, embracing the watershed where the northern branches of the Red Cedar and Iowa, and the eastern branches of the Des Moines, take their rise."* The southward continuation of the Minnesota moraines has been traced by the writer, as hereafter described, through this district, which is found with the exception of narrow belts, to be like nearly all the region explored during these two years, very productive and easily cultivated land.

Among the principal additions to our knowledge of the glacial period afforded by the explorations here reported, we may place, first, the occurrence of two well marked morainic series, composed of hilly and knolly drift, each a few miles in width, divided by a belt of smoother surface, from two or three to twenty-five miles

*Report of a Geological Survey of Wisconsin, Iowa and Minnesota, 1852; Introduction, pp. xxxv and xxxvi.

wide, extending through nearly this entire distance of 400 miles. This is found to be the character of the deposits accumulated both at the east and west borders of the ice-lobe, which reached southward from Minnesota to central Iowa. In Yellow Medicine and Lac qui Parle counties a third morainic range extends through a distance of forty miles, and is continued beyond in Dakota. As the course of the formation makes a loop like the letter U, having been accumulated by ice-fields covering the district enclosed, the outer moraine on each side is known to have been first made; then, after a retreat of the ice-sheet, probably followed by a re-advance, the inner moraine was formed; and, lastly, the third range, which lies still farther within this area; for the inner series would have lost their roughly knolly and hilly contour, if they had been covered by a moving ice-sheet, forming terminal deposits beyond them. Since the observation of this twofold, and in part threefold character of this formation, the writer finds that Professor Chamberlin records it as similarly exhibiting three distinct morainic belts, divided by smoother tracts, in a section between Black Brook (T. 32, R. 16) and St. Croix Falls, at the west side of Wisconsin.*

A second observation of much importance is that the abundance of lakes which dot the map of Minnesota and northern Iowa, extends only to the outer line of the moraine here described, which appears to have been accumulated at the border of the ice-sheet in our last glacial epoch. In southeastern Minnesota the glacial drift reaches fifty miles farther east to the driftless area, and in southwestern Minnesota covers Pipestone and Rock counties, beyond this moraine; but ~~with~~in these districts, and upon the large area in eastern and southern Iowa, and in northern Mi~~nnesota~~ssouri, which are covered by drift, lakes are very rare, and none of any considerable size exist. Professor Chamberlin has also noted the same presence of many lakes along the belt of the Kettle Moraine and northward in Wisconsin, and their absence from the region southward. As to what this remarkable difference teaches concerning the relative age of the drift upon these areas, or the conditions attending the earlier epoch, when an ice-sheet extended much farther south, we are not yet prepared to express an opinion.

Another point to which we wish to call the attention of glacialists is the great length, in proportion to the width, of the ice-lobe which accumulated at its east and west sides the looped moraine that reaches, in nearly parallel belts, from the Leaf hills 400 miles, and from the Head of the Coteau des Prairies 300 miles, south-

*Geology of Wisconsin, Vol. III., 1880; pp. 384 and 385.

southeast to central Iowa. The distance between the exterior limits of these belts, which measures the width of this ice-lobe at its greatest extent, is from 85 to 125 miles. If we compare this with its length, and consider the approximat~~ing local~~ ely level and uniform character of the district covered by the ice, and the areas at each side which it did not cover, it seems to be a necessary conclusion that this prolongation of the ice-sheet beyond the great expanse which it wholly covered farther north, was due principally to greater snowfall and colder temperature upon the district occupied by this ice-lobe, than on the adjoining areas at the east and west. Some portion of these ice-fields was doubtless supplied by a glacial current from the north, but the greater part was apparently the result of local climatic conditions. The maps accompanying Professor Dana's article on the causes of the driftless area, already referred to, indicate that, the present aqueous precipitation upon these districts continuing unchanged, a very cold climate would be likely to produce an ice-sheet lobed like that of our last glacial epoch; and that, with increased cold, it might extend farther south, enclosing an area not covered by ice.

The origin of the series of drift hills here described is confidently referred to the action of the continental ice-sheet, accumulating then at its margin and in medial lines within the ice-covered areas where converging glacial currents were pushed together. This conclusion is required by the partly near and partly remote sources of their material; by its generally unstratified condition; by its transportation next to these hill-ranges in courses nearly at right angles toward them, and by the variable elevation of the series, conforming to all the irregularities in altitude of the region across which it extends. Tables of heights, determined by railroad surveys within this region, and a list of elevations of these moraines, are placed at the close of this essay.

Directions in which glacial currents moved are shown on the map by arrows and dotted lines, which in this State represent the observations recorded in the following table.

Courses of Glacial Striæ in Minnesota,

Referred to the true meridian.

North shore of Lake Superior (Norwood and Whittlesey).....	S. 25°—45° W.
Vermilion lake (Whittlesey)..	S. 15° W.
Rainy lake (Whittlesey)..	S. 40°—60° W.
Lake of the Woods (G. M. Dawson)..........................	mostly S. W.

Duluth	W. S. W.
Hinckley, Pine county	S. 5° W.
Watab, Benton county	S. 15° W.
St. Croix Falls (Chamberlin)	S. 35° E.
Minneapolis, Nicollet island	S. 5° E.
Minneapolis, Hennepin island	S. 22° E.
Minneapolis, quarry opp. University	S. 12° E.
Big Stone lake	S. E.
Granite Falls	S. 45°—50° E.
Beaver Falls	S. 60° E.
Fort Ridgely	S. 60° E.
Redstone, near New Ulm	S. 25° E.
Jordan	S. E.
Posen, Yellow Medicine county	S. 50° E.
Echo, Yellow Medicine county	S. 50°—55° E.
T. 111, R. 38, Redwood county	S. 50°—60° E.
Stately, Brown county	S. 50°—55° E.
Germantown, Cottonwood county	S. 30° E. and S. 70° E.
Dale, Cottonwood county	S. 20°—35° E.
Amboy, Cottonwood county	S. 35°—70° E.
Delton, Cottonwood county	S. 15°—80° E.
Selma, Cottonwood county	S. 18°—22° E.
Adrian, Watonwan county	S. 20°—30° E.
Pipestone quarry	S. 20°—30° W.
Mound, Rock county	S. 25°—35° W.
1½ miles N. W. from last	S. and S. 35° W.
Northwest corner of Iowa (White)	S. — S. 8° E.

THE TERMINAL MORAINE IN STEELE, WASECA AND FREEBORN COUNTIES.

South from Faribault to the Iowa line this formation consists of two belts of knolly and hilly till, from one to several miles in width, extending from north to south, divided by a tract of gently undulating till, from six to fifteen miles wide. In Steele county the eastern or outer morainic belt extends through Merton, Havana, Aurora and Blooming Prairie, its eastern range of townships. It occupies the greater part of Merton, at the northeast corner of this county; but its hillocks, mounds or swells are only from 20 to 30 and rarely 40 feet high. Most of them consist of till, or drift clay, enclosing boulders; but here and there are mounds of irregularly stratified fine gravel and sand. The east third of Havana has a similar rolling surface, bordering the west part of Rice lake. Through Aurora this moraine is well exhibited in scattered mounds and hillocks, 15 to 40 feet high. On the road from Owatonna to Blooming Prairie and Austin, it is crossed in sections 9, 15 and 22, being here about three miles wide. At Aurora station, and for 1½

miles south, this formation is finely seen at the east side of the railroad, by which it is crossed in section 28. The boundaries of the moraine are very definite in this township. Its narrowest place in the county is found in section 28, north of which it is indented on its northwest side by a tract of lowland and marsh, which lies next west of the railroad, reducing the width of the hilly tract to one mile. At the west and southwest this quickly widens again to two or three miles, covering sections 29, 30, 31 and 32, of Aurora, and sections 25 and 36 of Somerset, with a profusion of knolls and hills, 20 to 50 feet high, sprinkled with boulders, principally granite and gneiss, mostly less than two feet in diameter, with occasional blocks or slabs of limestone, sometimes 6 or 8 feet long. These elevations are seldon prolonged more than a few hundred feet. The trend of their large axis is more frequently from east to west than otherwise, but this is not very noticeable. From the southeast corner of Somerset the moraine turns southward, and extends in typical hills and short ridges through the west two ranges of sections in Blooming Prairie. Here the trend of its separate elevation is most frequently from north to south, being parallel, as before, in its east to west trends, with the course of the whole series. In the west part of sections 8 and 17, Blooming Prairie these rough hillocks are well exhibited, being 20 to 50 feet above the depressions, and 75 or 100 feet above the neighboring creek.

This eastern belt of drift hills and knolls in Freeborn county is from a half mile to one and a half miles wide. It extends south, through Newry, Moscow and Oakland, in the east range of townships of this county, and next passes southwest through the southeast corner of Hayward and the center of Shell Rock, the two southern townships of the range next west. More exactly, its course in Newry is through sections 5, 9, 16, 21, 28 and 33, and in Moscow through sections 4, 9, 16, 20, 30 and 31. The roughest of this series in Freeborn county is in the school section 16, in Newry, where it presents the typical morainic contour in abundant small hills, short ridges, mounds and hollows through and over which a road extends from north to south. In Oakland and Shell Rock this morainic belt forms the water shed between the Cedar and Shell Rock rivers. Its course is through sections 6, 7, 17, and the east part of 18, 19 and 30, Shell Rock. This range is generally 25 to 50 feet above the smooth and nearly level or gently undulating till on each side.

The western or inner moraine lies in eastern Waseca county, and

in the southwest edge of Steele county, and extends from north to south in Freeborn county by Albert Lea. The width of this morainic belt varies from three to ten or twelve miles. Its hills are almost universally till or unmodified glacial drift, rising in smoothed but variable slopes, and exhibiting no parallelism or system in their trends. From Okaman, at the north line of Waseca county, southeastward through the northeast part of Iosca and in the southwest corner of Blooming Grove, two miles north of Waseca, these elevations are 30 to 50 feet high. Through Woodsville, within two to four miles east and southeast from Waseca, inconspicuous scattered drift hills and mounds, constituting a generally rolling surface, represent the morainic series. In Otisco, the next township south, it rises to its usual prominence in section 5, one and a half miles east of Wilton, where we find numerous steep ridges and round or irregular hills, more strewn with boulders than the other portions of this township, which are moderately rolling and occasionally hilly. The east two ranges of sections in New Richland are mainly covered by morainic mounds, swells and hills, 30 to 50 feet above the intervening hollows. In Steele county this formation occupies the northwest part of Meriden and the western two-thirds of Lemond and Berlin townships, being here made up of massive swells of smooth contour, 20 to 40 feet above the frequent depressions, many of which contain sloughs. The east portion of this rolling land is three or four miles west of Straight river. The greater part of the basin of the Shell Rock river in Freeborn county is included in this morainic belt, which expands to a breadth of 8 to 12 miles. In range 21, this includes Bath, Bancroft and Albert Lea townships, and the northwest half of Freeman, in range 22, the southeast third of Hartland, Manchester, except its west margin, Pickerel lake, exepting sections 6, 7, and part of 18, and Nunda, and in range 23, the southeast corner of Alden, and Mansfield, the southwest township of the county. In Mansfield these drift hills enclose a large plain of modified drift which extends five miles west from Bear lake. The hills of this belt are mostly rather smooth swells of gracefully rounded outlines, but often with steeply sloping sides. No prevailing trend is noticeable. Their most conspicuous developement is found about three miles west-northwest from Albert Lea, being within a mile westward from White lake in sections 1 and 2 of Pickerel lake township. Here their crests are from 75 to 100 feet above the hollows; and in other parts of this county they are generally from 40 to 60 feet high.

Prominent drift hills which occur in Kiester, the southeastern township of Faribault county, are so closely connected with this moraine in southwestern Freeborn county, that they appear to be a part of the same belt, and are probably a terminal deposit of the ice-sheet. If so, these hills show that near the close of this glacial epoch the ice-margin here became indented by a re-entrant angle, between the two confluent ice-currents by which the medial moraine that reaches northwest across this county was formed. The most hilly portions of Kiester are its south side for a width of one mile, and a belt through its northeast portion from sec. 13 to secs. 3 and 4. The last mentioned hills are the most conspicuous of this region, and are visible fifteen miles to the north and west. Their height is from 100 to 200 feet above the lowland in these directions and above Bear lake in Freeborn county; the highest points, which are in the southwest quarter of section three, being about 1400 feet above the sea. These are massive hills of till, of irregular outlines, but trending somewhat more from east to west than in other directions.

Northwest from the Kiester hills, a belt of hilly or more or less rolling land, believed to be contemporaneous in origin with the foregoing, and formed as a medial moraine by conveying ice-currents reaches twenty miles to the southwest part of Lura; and ten miles beyond appears to be represented by a hilly and rolling tract in the northwest part of Sterling, in Blue Earth county. In Foster, the township next north of Kiester, it is boldly rolling in hills of till 50 to 75 feet high, from section 28 north and northwest by Rice Lake, where it extends with a width from one-half mile to one mile at each side of the lake. Still farther northwest the same contour and material border the east, north and west sides of Walnut lake, including the most of sections 25 to 28 and 33 to 36, of Walnut lake township. In sections 16 and 8, 2½ to 5 miles northwest f.om this lake, is an area of swells, knolls, and northwest to southeast ridges, 30 to 40 feet high, of very gentle slopes, composed mainly of stratified sand and fine gravel, as shown by wells, which do not penetrate these deposits of modified drift at the depth of 50 feet. In Barber, the township next west, a prominently rolling tract is found about the little lakes in sections 14, 15, 22 and 25. The material here is till, and its swells or hills are 30 to 50 feet above the hollows. Through six miles thence northwest a more or less rolling surface of the unmodified glacial drift continues in a belt about two miles wide, to the south-west part of Lura and the east edge of Delavan. This morainic belt divides two

extensive areas of till, which are characterized by a very smooth, flat surface.

EXPLORATION OF THE TERMINAL MORAINE IN IOWA.

The course and general character of this formation in its continuation from Freeborn county southward into Iowa, have been explored through portions of Worth and Winnebago counties, Cerro Gordo and Hancock, Franklin and Wright, Hardin and Hamilton, Story and Boone counties, to Mineral Ridge in northern Boone county, 90 miles south of the Minnesota line. Through the north half of this distance it continues in two belts of hilly and knolly or rolling till, from one to five miles in width extending approximately from north to south, nearly parallel with each other, and divided by a tract of slightly or moderately undulating till, 5 to 15 miles wide. At the northeast corner of Hancock county, these belts are united by a notably morainic area, three or four miles in width, lying at the north side of Lime creek, and culminating in Pilot Mound, which is about 200 feet high, being the most prominent hill found in the whole extent of this moraine in Iowa. Westward from Pilot Mound, a typically morainic belt, varying from one half mile to three miles in width, extends in northern Hancock county along the north side of Lime and Silver creeks, passing about a mile south of Forest City, and by Lake Edward, Crystal lake, and Buffalo Grove, to Lake George, terminating ten miles west of the principal north to south moraine, of which it appears to be a medial branch, produced by convergent ice-currents. Forest City and Lake Edward are respectively five and ten miles west of Pilot Mound, and from them another tract which has frequent moraine accumulations of similar medial origin, varying in width from three to six miles or more, reaches northwestward forty miles through western Winnebago county and northeastern Kossuth county, to East Chain and Fairmont, in Minnesota.

South from Pilot Mound in Hancock county, this terminal line of drift hills has no branch like the foregoing for the next seventy miles, to Mineral Ridge, which may have had a similar origin, but is believed to be more probably an inner belt of the terminal moraine, though the cause of its outer series, supposed to continue southward, has not been explored. Conspicuous portions of this formation are found in eastern Wright county, and in the south-west part of Franklin county; and its entire extent has a promi-

nently undulating, rolling, or hilly contour, in notable contrast with the smooth, slightly undulating and often nearly level areas at each side. The material of these tracts is chiefly till, with the occasional exception of plains of stratified gravel and sand, which extend a few miles east or southeast from the moraine. These deposits of modified drift are believed to have been brought by rivers that flowed down from the surface of the ice-sheet at the west. Irregularly bedded gravel and sand occur frequently in the hillocks of the moraine, sometimes forming their entire mass, but quite as often in pockets or beds of small extent and varying from less than one foot to ten feet or more in thickness, included in the till which almost universally makes up the greater part of this formation. Aside from such enclosed layers of modified drift, this till rarely shows any marks of stratification, and contains more boulders than upon its nearly level tracts.

In Worth county the eastern belt of this moraine enters Iowa in sections 8 and 9, Northwood, and extends four miles southwest, with a width of about $1\frac{1}{2}$ miles, to section 24, Hartland; and then three miles south to the northeast corner of Brookfield. It consists of uneven swells and hills, 30 to 40 feet above the intervening hollows, and 50 feet above Northwood, which is situated $1\frac{1}{2}$ miles southeast, on a plain of valley drift about 20 feet above the Shell Rock river. Next this belt appears to be broken and removed by an offset six miles to the west; and thence its course is south through the east part of Bristol, and through sections 2, 11, 14, 23, 27 and 33, Fertile, its southeast border, being about $\frac{1}{2}$ mile northwest of Rhode's Mill, in section 34. In these townships the formation is in knolls, hillocks and short ridges, trending to the south or southwest, and 30 to 60 feet high. At the southwest corner of this county these morainic hills become more abundant and abrupt, and form a very rough wooded belt two or three miles wide, for a distance of six miles west from Rhode's Mills to Pilot Mound. This tract includes parts of four counties, and is bounded on the ~~nor~~south by Lime creek.

In Cerro Gordo county the eastern morainic series is represented by a rolling, partly wooded tract, south of Lime creek and 75 feet above it, extending about two miles southeast from Rhodes' Mill, and then turning south. Its next eight miles to Clear lake are a moderately rolling belt from one to two miles wide, and 50 feet higher than the smooth expanse, which reaches thence eastward as far as the eye can see. At the south side of the east part of Clear lake, this moraine occupies a width of about one mile, and is crossed

by the road to Belmond; it here consists of many mounds and hillocks, not rising above the general level of the smooth land at each side. Its farther course has not been traced; but the east side of the southwest township of this county, 9 to 15 miles south of Clear lake, reported to have a rolling and knolly surface, probably belongs to this morainic series, and suggests that it will be found to extend approximately south through the east part of range 22 in southwestern Cerro Gordo and northwestern Franklin counties, joining the western belt of this moraine at the southeast corner of Morgan, 10 miles north of Alden.

About a third part of Winnebago county is covered by these hilly drift deposits. Their principal belt, which is the continuation of the range seen at Albert Lea and east of Bear lake in Freeborn county, enters Iowa at the northeast corner of Winnebago county and extends south with a width of from two to four miles, through the townships of range 23, between Lime creek and the east line of the county, to Pilot Mound. The southeast border of this belt is quite definite at a point two miles north and again at one mile west of Lake Mills. Here and southward it consists of massive hills of till 40 to 75 feet high. A branch of this moraine, consisting of rough hills, strown with many boulders, and occupying a width of about two miles, crosses Lime creek a few miles south of the State line, and extends northwest into Kiester, the southeast township of Faribault county. Northeast from this tract is a plain of modified drift, reaching five miles to Bear lake.

The medial moraine which extends northwest from Forest City and Lake Edward attains its greatest height in the north part of T. 98, R. 25, where it is 100 feet above the general level. In northeastern Kossuth county this tract expands to a width of ten miles and reaches from Ramsey, at the east side of Union Slough, north and northwest to the State line, lying on both sides of the head stream of the Blue Earth river. Its northeast border reaches 1½ miles into the south edge of Elmore and Pilot Grove in southwestern Faribault county, forming hillocks and short east-to-west ridges of till, 30 to 50 feet high. Thence these accumulations of till occur scatteringly in southeastern Martin county to East Chain and less prominently to Fairmont. Their contour in these townships is seldom rough, but rises in swells 25 to 50 feet above intervening depressions, with trends more frequently from northwest to southeast than in other directions.

In Hancock county the western and principal belt of the terminal moraine extends from Pilot Mound six miles southwest and

then nearly due south through range 24. Pilot Mound in the north part of section three, Ellington, rises about 250 feet above Lime creek, which is two miles farther south. A multitude of rough drift hills, mounds and short ridges, 50 to 100 feet lower than this, reaches six miles eastward and two or three miles to the west and northwest. All these accumulations are till, trending more frequently from east to west than otherwise, of all heights from 25 to 100 feet above the intervening depressions, which are often bowl-shaped or irregular hollows, containing sloughs. The top of Pilot Mound is some 200 feet above the average of the country to the north and south, and from 100 to 150 feet above the sloughs in its vicinity. The hills of Kiester, in Minnesota, 22 miles distant, are visible but not prominent, bearing N. 10° W.* The highest hills seen in Winnebago county are those in the north part of T. 98, R. 25, bearing N. 65° W.* and twelve miles distant. South from Pilot Mound the morainic contour reaches 1½ miles, and is succeeded by a plain of stratified sand and gravel, one-third mile wide, on the north side of Lime creek and 15 to 25 feet above it. These tracts are mainly wooded, but south of this creek the surface soon rises 40 or 50 feet to a broad prairie of moderately undulating till. From Forest City and Silver creek the terminal moraine passes south in a rolling and knolly tract which is from two to three miles wide, through the center of Madison; six miles wide in the north part of Garfield, reaching from the east fork of the Iowa river to Eagle lake; and about three miles wide through the west half of German and of T. 94, R. 24, bordering and crossing the west fork of the Iowa river, and including the Twin lakes.

The hillocks and swells of this tract consist principally of till. They are from 30 to 60 feet high, and average about 40 feet above the comparatively level areas on the east and west. Their prevailing trend, like that of the frequent sloughs of this region, is approximately from north to south. A plain of modified drift is found east of this moraine, reaching five miles from Concord and Garner northeastward. At Garner this is stratified clayey sand and fine gravel, underlain by till, which forms the gently undulating surface at Concord and thence south through Ell and Avery. In this drift sheet the east fork of the Iowa river has cut a channel or valley, which increases in size till at the south line of the county it is one-third mile wide and 75 feet below the general level to which the ascent is by steep bluffs.

A conspicuously rolling, hilly and knolly tract branches from the

*Referred to the true meridian.

terminal moraine in the north edge of Hancock county, and extends ten miles westward to Lake George, beyond which the contour on all sides is smooth and only slightly undulating. Many of the hillocks and ridges of this tract trend nearly from east to west. Their material is till, often containing an abundance of boulders. Their height along the north side of Silver creek, in sections 9, 10 and 11, Madison, is 20 to 50 feet, and nearly the same about the lakelets in sections four and five of this township. Lake Edward, Crystal Lake, Lake George, and the series of sloughs and lakelets which reaches three miles southeast from the last, are bordered by very rough, morainic bluffs, which rise steeply 50 to 75 feet at the north side of these lakes. Their top is the edge of a plateau of till, which extends four to eight miles north with a nearly level but slightly undulating surface. Prominent hill ranges of equal height occupy a width of two miles south of Lake Crystal, and of one mile southwest from Buffalo Grove and Lake George. Toward this tract, if it is a medial moraine, currents of the ice sheet and descending slopes of its surface converged from the northwest and southwest. Rivers produced by glacial melting would accordingly flow upon the surface of the ice to this lowest portion of its border; and we find modified drift which was apparently brought by such streams, forming plains that extend several miles southeast from Lake Edward and cover a width of four miles half way between Clear lake and Britt. The only kames observed are at the southeast sides of Crystal lake and Lake Edward, and consist of a few mounds and ridges ten to fifteen feet high, composed of irregularly bedded gravel and sand.

In Wright and Franklin counties the terminal moraine extends south four miles to Gertrude or Twin Sisters lakes, four miles west of Belmond; thence south, southeast eighteen miles, by the east sides of Cornelia (or Little Wall) and Elm lakes, into Vernon, the southeast township of Wright county; and next east, and southeast nine miles, and then south six miles, crossing the Iowa river at the east side of Wright county, and lying on the north and east boundaries of Oakland, the southwest township of Franklin county. Its width along this distance is from one and one-half to three miles; the material is till, often enclosing and strown with many boulders of granites, schists and limestone; in height its knolls, ridges and hills vary from ten to one hundred feet above the intervening hollows; and their trends, wherever any system is noticeable, are parallel with the course of the moraine. The elevation of this hilly belt above the smooth expanses of till on

each side is mostly from forty to seventy-five feet, but due east from Clarion, it does not rise above the general level. This moraine is crossed by the road from Belmond to Clarion, and is there one and one-half miles wide, and consists of many small hills and ridges ten to forty feet above its enclosed hollows of irregular form, which contain frequent lakelets and small sloughs. Its height above the Iowa river gradually rises from fifty feet at its east side to one hundred and twenty-five or one hundred and fifty feet at the west; and it is succeeded by gently undulating till, which maintains about the same height as the upper portion of the moraine and extends indefinitely westward. One to two miles farther north, in the vicinity of Gertrude lake, these morainic hills rise fifty feet higher; and thence a medial branch of this formation reaches three miles westward in the north part of sections 1, 2 and 3, Lake (T. 92, R. 25), culminating in the "Big Mound," which appears to be the highest land in Wright county. The most broken portion of the moraine in this county is ten miles southeast of Clarion, in sections 32 and 33, Blaine, and 4, Vernon, consisting of many mounds and short ridges, twenty-five to seventy-five feet above the intervening hollows, fifty feet above the smooth land westward, and about one hundred and twenty-five feet above the Iowa river. Southeastward this moraine reaches in low knolls to the east half of section 26, Vernon; but its most conspicuous deposits are found on the opposite side of the Iowa river, in southwestern Franklin county, extending east and then south at the north and east sides of Oakland, averaging two miles in width, about half of which is in Morgan and Lee townships, next on the north and east. This belt is very rough with many hillocks and short ridges, generally trending in the same direction with the series, composed of till with abundant boulders, and divided by depressions which often contain sloughs or lakelets. Its height is fifty to seventy-five feet above the smooth areas of till on each side, and about one hundred feet above the Iowa river. The south part of this formation in Franklin county, lying a few miles north of Alden, is commonly called the "Blue Mounds."

Between Alden and Story City the course of the moraine coincides approximately with the line which divides Hardin and Hamilton counties, but scarcely enters the latter, excepting for a distance of eight miles at its southeast corner. In northern Hardin county the line of this formation is again crossed by the Iowa river, southwest of which it reappears in a knolly belt of gravelly till, fifty feet above the general level both to the east and west.

This lies between one-half mile and two miles west of Alden, and thence extends twelve miles south, southwest and south along the west border of Hardin county, reaching one-fourth or one-half mile west of the county line and one to two miles from it eastward. Here and in southeastern Hamilton county it is moderately undulating till, often containing many boulders. Its crests are twenty to thirty feet above the depressions, and twenty-five to fifty feet above the adjoining country. Six to eight miles north of the south line of these counties, the width of this rolling tract is increased to three miles, lying mostly in Hardin county. Thence its course is deflected southwestward and its width narrows to one mile in the south part of Scott, the southeast township of Hamilton county. Its last mounds and knolls seen east of Story City are in sections 28 and 33, Scott, rising forty to sixty feet above the flat area of till, which reaches thence one and one-half miles west and southwest and indefinitely toward the south and southeast, being about thirty-five feet above the Skunk river and twenty to twenty-five feet above its bottomland. Beyond the valley eroded by this river, the same plain of till extends two miles to the southwest and indefinitely to the northwest from Story City. At its southwestern limit a prominently rolling and hilly tract of till rises fifty to seventy-five feet higher and extends thence twenty-five miles west through the northern tier of townships in Boone county.

The Des Moines river intersects this range eight to ten miles north of Boone and Ogden. East of the river it is widely known as Mineral Ridge; and a kame-like hill 1½ miles west of the Des-Moines, and two miles south of the main series of this moraine, but doubtless accumulated at nearly the same time, is called Pilot Mound. The width of this belt averages about three miles. It extends westward through the center and northwest quarter of Harrison, the northeast township of Boone county, where its height is 125 to 150 feet above Squaw creek; but this elevation is due, at least in some portions, to underlying bed-rock, which was encountered at a depth of 35 feet, by wells upon this range in Sec. 16, Harrison. Its material here and westward is till, in which boulders often abound, being of all sizes to 5 and rarely 10 feet in diameter. This belt occupies the north part of Dodge, the township to the west, in which its height contains nearly the same, being about 50 feet above the smooth areas of till that stretch as far as the view reaches to the north and south, and about 250 feet above the Des Moines river, which has here cut a valley 200 feet deep. The

largest hills and ridges of this district are in Sec. 6, Harrison, and Sec. 1, Dodge, where they trend nearly from east to west, and rise 75 or 100 feet above adjoining depressions; but because of their comparatively low position they do not overtop other portions which have a less broken surface. The contour of the moraine at the village of Ridgeport or Mineral Ridge, three miles east of the Des Moines river, and for the next six miles east, as also along the north edge of the county for six miles west of the Des Moines river, has been well described by Dr. C. A. White, who writes; "It consists, to a considerable extent, of a collection of slightly raised ridges and knolls, sometimes interspersed with small shallow ponds; the whole having an elevation probably nowhere exceeding fifty feet above the general surface, but being in an open prairie, it attracts attention at considerable distance.*"

Pilot Mound gives its name to the township in which it is situated. This is nearly a round hill about 75 feet above the smooth expanse of till which reaches north two miles to the moraine, east one mile to the bluffs of the Des Moines valley, and southward beyond the horizon. Its base covers a diameter of $\frac{1}{8}$ mile, and it rises by steep slopes to a rounded top which has its highest point in the southwest corner of Sec. 21, about three rods east of its west line. This mound is wholly composed of gravel and sand, obliquely stratified, with no till or boulders. Clear sand, in beds 3 or 4 feet thick, occurs at the top of the mound; but it is mainly coarse gravel with pebbles up to six inches in diameter. About half of the pebbles under two inches are limestone, but those of larger sizes are mostly granites and schists. Potsdam quartzite is rare; it may be that one pebble in five hundred is from this formation. West and southwest from Pilot Mound, a moderately rolling surface 50 to 75 feet lower, composed principally of till, extends two or three miles, terminating in Sec. 30, which has mounds 20 to 30 feet high.

A belt of knolly till, similar to Mineral Ridge, extends west from section nine Pilot Mound, into the northeast corner of Grant, the northwest township of Boone county, beyond which its farther course has not been explored; but it is supposed to turn north-northwest, lying within five miles west of the Des Moines river, and to be continuous to a typically morainic tract which was found twenty miles farther north, between 2 and $3\frac{1}{2}$ miles west of Fort Dodge. This tract has many rough hillocks of till, fifteen to thirty feet high, with abundant metamorphic and some limestone

*Geology of Iowa, 1870, vol. 1, pp. 98 and 99.

boulders, but few or none of potsdam quartzite. It may be that similar accumulations are traceable onward in the same course 30 miles to the branch which extends from the terminal moraine at the west side of Palo Alto county east and southeast to the edge of Pocahontas county at the south line of T. 94, R. 32. In that case it would appear that the series of drift-hills explored in northern Boone county, and their tract west of Fort Dodge, are portions of a terminal moraine reaching from northwestern Story county to western Palo Alto county. They must then be contemporaneous with the inner belt of this looped moraine, which extends through eastern Waseca county and by Albert Lea on the east, and by the east side of Spirit lake, Heron lake and Lake Shetek to Gary on the west.

The outer belt of the terminal moraine at the west side of its loop is found 35 miles southwest from Mineral Ridge, in northern Guthrie county, where its course is from southeast to northwest and it has been traced continuously thence to the north line of Iowa and across southwestern Minnesota into Dakota. From the vicinity of Pilot Mound the next thirty miles to the south and southwest are smooth and only gently undulating till, with few boulders. This tract intervening between Mineral Ridge and the terminal moraine in Guthrie county shows that these cannot be portions of one continuous belt; and if they were formed at the same time, Mineral Ridge must be a medial moraine like those which extend from Kiester northwest across Faribault county, and from Forest City to Fairmont and Lake George.

The exploration of these belts of hilly and knolly drift, reaching from the south line of Minnesota to the center of Iowa, leaves no doubt to the writer that they are opposite portions of a continuous terminal moraine which has its course in a curve like the letter U. Professor Chamberlin has shown that this moraine crosses Wisconsin in a series of loops of this kind; and the large driftless area in southwestern Wisconsin and portions of the adjoining states, surrounded on all sides by glacial deposits, proves that at the time when the ice-sheet reached farthest, its southern portion was similarly divided into vast lobes, which, through a part of this epoch, became confluent at the south side of the driftless area. The lines of moraine here described in Minnesota and Iowa are about midway between this region, which has escaped glacial action on the east, and the limits of glacial drift on the west which extends southward and south-southeastward from about 40 miles west of Bismarck through Dakota and across Nebraska into northeastern

Kansas. These lines of hilly drift are thus more parallel with the boundaries of glacial action at its time of greatest extent, and are supposed to mark the similar limit attained by the ice-sheet of the last glacial epoch. A very significant feature is the frequent occurence of lakes upon the area enclosed by this looped moraine; while in the regions beyond it to the southeast and southwest, though they also are in large part till, lakes ~~and rivers~~ are rare or entirely absent. The connection between the moraine that reaches from the south line of Minnesota in Freeborn county to the northwest part of Story county and Mineral Ridge, and that which is next to be described, is believed to extend southwestward through Story and Polk counties, probably crossing the Des Moines river within a few miles southeast of Des Moines; then westward along the south side of Raccoon river, through the north edge of Madison county; and northwestward along the east side of Middle Raccoon river, through southwestern Dallas county and northeastern Guthrie county.

This western line of the terminal moraine was encountered in the south part of T. 81, R. 31, in northern Guthrie county, after traveling thirty-five miles southwest from Mineral Ridge and Pilot Mound. Its course thence is to the northwest and north through Carroll, Sac, Buena Vista, Clay and Palo Alto, Emmett, Dickinson and Osceola counties, into Minnesota, reaching in Iowa 120 miles to the north and 60 miles to the west. The width of this belt along the greater part of this distance is from two to four miles; but in Clay, Palo Alto and Dickinson counties it is from eight to twelve miles. Its contour is nearly as in other portions of this formation, presenting many hillocks and short ridges which vary in height from 20 to 50 feet above the intervening hollows, and usually rise 30 to 50 feet and rarely 75 or 100 feet above the adjoining country. Eastward a smooth and nearly level expanse of till with few boulders stretches 50 to 75 miles to the eastern line of this moraine. Westward the land next to this belt from Storm lake to the Minnesota line, is nearly the same as on the east; but south of Storm lake the till on the west is buried beneath the loess, which in somes portions has a smooth and gently undulating surface, but generally it has been sculptured by rains, rills, creeks and rivers, to a prominently rolling contour, rising to crests, ridges and plateaus, 100 to 150 feet or more above the streams. Near the moraine this erosion has cut through the loess, and from 50 to 75 feet into the underlying till. The surface of the loess throughout this distance of 75 miles, averages as high as the tops

of the morainic hills which lie next to it on the east, and at their lower portions, surpasses them by 25 or 50 feet, while its elevation above the expanse of till eastward is from 50 to 75 feet. The material of the moraine is chiefly till, with boulders everywhere frequent, and occasionally very abundant, probably averaging ten or twenty times more numerous than on the smooth areas of till. These are granites, schists and limestone, as in the eastern line of this formation, with the addition of a considerable proportion from the red Potsdam quartzite which has extensive exposures in southwestern Minnesota from New Ulm to Pipestone City and Luverne. In this moraine on the east from Albert Lea south to Mineral Ridge, these quartzyte fragments are very rare; but along its entire coast on the west, from Guthrie county into southwestern Minnesota, they are common, and make up from one-twentieth to one-third part of all its boulders. The only exposures of bedrock seen in the regions traversed by this moraine, are in Guthrie county, where the Nishnabotany sandstone of Cretaceous age outcrops along the Middle Raccoon river, at Rock Bluff mills, situated in the N. E. ¼ of Sec. 27, Highland (T. 81, R. 32), and at other points. The hills of the abjoining moraine, covered at the surface by knolly till with many boulders, are found by wells to consist in some cases for their lower portion of this sandstone, showing that the contour here partly conforms with the unequally eroded surface of rock beneath the drift.

In northern Guthrie county the morainic belt covers a width of about two miles next northeast from the Middle Raccoon river, reaching to Swan lake in the southeast quarter T. 81, R. 31. Its elevations mostly trending north-westward, are from 30 to 75 feet above the hollows. Boulders abound and include many of Potsdam quartzyte, which occurs in fragments of all sizes up to five feet in diameter. They are most plentiful where the surface is most broken. as in section 18, of Highland, and sections 13 and 12, of Grange, the northwest township of this county. The hills, knolls, and ridges of these sections appear to be composed wholly of till. In a well near top of one of them, this was yellowish to a depth of 25 feet, then dark bluish and harder for 22 feet below, to water which arose 16 feet.

In Carroll county this belt, from 1½ to three or four miles wide, continues northwestward by Coon Rapids, Carrollton, Carroll and Maple Junction to Breda. From the southeast corner of the county to Gustine Grove, two miles beyond Carrollton, it consists of swelling hills of till, not so rough as to be typically morainic, which

occupy a width of 1½ to three miles along the northeast side of Middle Raccoon river, rising from 100 to 150 feet above it, and averaging 75 feet or more above the smooth sheet of till on the east. Between one and two miles northwest from Carrollton some of these hills, 100 feet above the river, consist of loess at the surface, free from pebbles to a depth of ten or 12 twelve feet. This has the same yellowish color as the upper part of the till. Other hills near have many rock fragments, both large and small, being common till, but morainic in the abundance of boulders. From Gustine Grove to Carroll the moraine holds its straight course northwestward, lying on the southwest side of the river, which here flows east and then south. Its height is from 100 to 125 feet above the river. A part of its mounds and hillocks through this distance are covered by loess, but mostly their surface is till with numerous boulders and pebbles. A lakelet two miles south-east of Carroll, and frequent sloughs, lie in the depressions of this formation. Beyond Carroll the Middle Raccoon river is again its southwest boundary, from which it reaches to Mount Carmel. It here consists of moderately rolling till, with crests 30 to 50 feet above its hollows; and this character continues to the north line of the county where its course is through the northeast part of Wheatland, its northwest township, with a width that reaches about a half mile east and two miles west of Breda.

Across Sac county and to the center of Buena Vista county, a distance of thirty-six miles, the course of the moraine is a few degrees west of north, and its width is from two to four miles. In Sac county this extends from the southeast quarter of T. 86, R. 36, to the northwest quarter of T. 89, R. 36. Wall lake lies within the limits of this belt, and its west border is close east of the railroad town of Wall lake. Farther to the north, Indian creek and lake are at the west side of this belt, which through Sac county consists of moderately rolling and often knolly till, containing frequent boulders and pebbles. Its crests are 20 to 30 feet above the adjoining hollows, sloughs and lakes. Next to the west the loess rises forty to fifty feet higher than the moraine, forming nearly level-topped plateaus and ridges, as in the southwest quarter of T. 86, R. 36, and at the west side of the Boyer River west of Wall lake, or smooth swells which rise in long slopes thirty to fifty feet above the intervening depressions, sometimes having considerable gravel and boulders up to one foot in diameter at their top, apparently due to exposure of the underlying till, as in the six miles north from the town of Wall lake, and in Ts. 88 and 89, of R. 37. The

lowest point of the watershed between the Mississippi and Missouri rivers in the northern two-thirds of Iowa, appears to be the slough which reaches from Wall lake, four miles southwest to Boyer river.

In Buena Vista county this belt of rolling and knolly till, from two to three or four miles wide, continues north-north-westerly by the east end of Storm lake and to the south part of Scott, 7 miles north of this lake; thence it bends to the north and northeast, and passes by Grass Lake and Green Mound, to Pickerel Lake at the northeast corner of the county. From the northeast part of this belt a branch extends six miles south through the range of sections from 2 to 35 in Lincoln (T. 92, R. 36.) Both in this branch and in its main series, the hillocks, mounds and short ridges of this formation usually rise only from 10 to 30 feet above its depressions. Rock fragments of all sizes up to two or three feet in diameter abound, but larger boulders are infrequent. The west border of this belt is a half mile east from the town of Storm Lake. Its knolly surface is well seen at two miles east, two to three miles north, and five miles north of this town. Green Mound, situated in Sec. 19, Poland, five miles southwest from Pickerel Lake, is one of its most conspicuous hills in this county, though only about 50 feet high. Scarcely anywhere in Iowa does this moraine attain such height that it deserves to be designated on an ordinary map; but in a study of the glacial drift, its rough surface and its abundant rock fragments very clearly distinguish this formation, in its two nearly parallel north to south belts, from the smooth sheet of till, holding few stones and boulders, which covers the intervening area. In crossing this expanse 80 miles wide, from eastern Buena Vista county east to northwestern Hardin county, drift and contour like those that characterize this moraine, were seen at only one place, 2 to 3½ miles west of Fort Dodge, as already described.

Northward the moraine is 8 to 12 miles wide, occupying the greater part of the east range of townships in Clay county and the west range in Palo Alto county. Its material is till with many boulders. Much of Swan Lake, the northwest township of Pocahontas county, and of Rush Lake and Silver Lake in southwestern Palo Alto county, have the rolling or knolly surface of this formation, with crests 20 to 40 feet high; but its most broken contour and most prominent hills, 50 to 75 or 100 feet in height, are found northwest of Pleasant and Mud lakes in the southeast township of Clay county. About Elk and Elbow lakes and Ruthven, its mounds, ridges and hillocks are 20 to 60 feet above the depressions

and lakes. Farther to the north the moraine is divided into two belts, one of which passes by the east side of Lost Island and Palo Alto lakes into Emmett county, while the other lies south and west of Lost Island and Trumbull lakes and extends north into Dickinson county. Between these belts; in their course for 25 miles to Spirit Lake, is a tract of smooth, moderately undulating till from four to six miles wide. The eastern series of drift hills here and in their continuation across southwestern Minnesota, corresponds to the series at the east side of this morainic loop, as at Albert Lea. These are an inner terminal moraine which was evidently accumulated at some time later than the outer moraine, but both appear to have been formed by the ice-sheet of our last glacial epoch. It has been shown on a preceding page that Mineral Ridge is probably a portion of the inner belt of this formatiou, and that it may be traceable across Webster and Pocahontas counties to a branch which extends southeastward from the outer moraine in Palo Alto county. This branch first takes an easterly course from the vicinity of Silver Lake through the south part of Great Oak township to the Des Moines river, 7 miles southeast of Emmettsburg. Thence it turns southerly, occupying nearly the entire northwest quarter of Ellington (T. 94, R. 32), and continues in a narrow line of knolls from the center of this township to its south line. It consists of till with many small and large boulders, and its surface rises in knolls and short ridges 20 to 30 feet above the general level, and 50 to 75 feet above the Des Moines river. The morainic hills in the western townships of Palo Alto county, most typical in Highland and in the west part of sec. 1, at the northeast corner of Silver Lake, are 125 to 150 feet above this river, and from 40 to 60 feet above Rush, Silver, Elbow, Lost Island and Palo Alto Lakes.

The inner morainic series lies at the west side of the Des Moines river in Emmett county, extending north through Twelve Mile Lake, Esterville, and Emmett, to west range of townships. It is very finely exhibited for three miles to the south and east from Twelve Mile Lake, its highest portions being about forty feet above this lake or one hundred and fifty above the river. Here and onward through this county and in northeastern Dickinson county, it consists of typically rough, knolly till, with the usual abundance of boulders, one-third to two-thirds of which are the red Potsdam quartzyte. The width of this belt in Emmett county is from two to three miles, and its height is from one hundred and twenty-five to one hundred and seventy-five feet above the Des Moines.

Twelve Mile and Cheever lakes lie at its west boundary, beyond which the west edge of Twelve Mile lake and Estherville and the next four or five miles into Dickinson county are slightly undulating till, which mostly lies twenty-five to fifty feet lower than this moraine, but rises northward to a height of twenty-five feet above it at a half mile south of Swan lake. East of the Des Moines river its bluffs in Emmett county are from seventy-five to ninety feet high, and from their top a gently undulating sheet of till, maintaining nearly the same elevation, stretches eastward into Kossuth county and beyond the East Fork of the Des Moines. In the northern, two-thirds of Superior, the northeast township of Dickinson county, this series of rough drift hills turns westward and extends with a width of about three miles by Swan lake to Spirit lake. Their height is twenty-five to fifty feet above the numerous enclosed sloughs and lakelets, being in the east half of the township from one hundred and fifty to one hundred and seventy-five feet above the Des Moines river and fifty feet above Swan lake, but rising in its west part fully fifty feet higher to a watershed about seventy-five feet above Spirit lake.

In Dickinson county the outer belt of this moraine covers about half its area, including the west edge of Lloyd and Richland (Ts. 98 and 99, of R. 35), the northeast part of Milford (T. 98, R. 36), and nearly all of Center Grove, Lakeville and Excelsior, and of Spirit lake, Diamond lake and Silver lake (Ts. 99 and 100, of Rs. 36, 37 and 38). Its material throughout this county is the usual till with many boulders, of which from one-sixth to one-third are Potsdam quartzyte. Its surface is diversified by frequent hillocks and knolls, whose crests are from twenty to forty feet above the intervening hollows, sloughs and lakelets. This county has the most notable group of lakes in Iowa, distinguished equally for their beautiful scenery and for their abundance of fish and game. They are Spirit lake, four miles in diameter and the largest in the State, lying just south of the State line at the northeast side of this morainic belt, and the West and East Okoboji lakes, each about six miles long, lying inside its limits, with more than a dozen small lakes near them, varying from one-fourth to one mile in diameter. The maximum depth of Spirit lake is reported to be about 50 feet; of West Okoboji, in its north half, 55 feet, and in its south half, more than 100 feet; and of East Okoboji, 15 feet toward the north and 25 feet toward the south. The Okoboji lakes have the same level, and are from two and one-half to four feet below Spirit lake, according to their varying stages of water.

Their height above the Des Moines river at the State line is estimated to be about 150 feet. Nicollet's barometric observations made Spirit lake 1310 feet above the sea ; but this appears to be 75 or perhaps 100 feet less than the truth. East of Spirit and East Okoboji lakes these tracts of hilly and knolly drift rise 75 to 100 feet above them ; the highest elevations between the Okoboji lakes are 50 to 75 feet ; and the typically rough, morainic hills west of West Okoboji and Spirit lakes are from 75 to 125 feet high. The northwest part of this county has frequent swells, knolls, and short ridges, which rise 10 to 40 feet above the depressions, but none of them much exceeds the average height of the whole region, which gradually rises westward, and attains in northeastern Osceola county, 12 to 25 miles distant, an altitude from 75 to 150 feet above the highest hills near Spirit and West Okoboji lakes.

In Osceola county the south-west boundary of the morainic belt runs from Sec. 25, T. 99, R. 39 west, north-west to Ocheyedan mound, and thence north-westward coincides nearly with the course of Ocheyedan creek. Its width extends from this limit north-east into the edge of Minnesota ; but it encloses a tract of nearly level, gently undulating till, 4 miles wide and 5 miles long, reaching from Rush lake east to the county line. The contour and material of the moraine continue the same as in north-western Dickinson county. The highest portion of this formation in Iowa, and probably at the same time the most elevated ground within the limits of the State, is either the top of Ocheyedan mound, or the smaller swells and hillocks next to the State line, 9 miles further north-west, which are about 1,675 feet above sea, the railroad station of Bigelow, near by in Minnesota, being 1,631. Ocheyedan mound situated in the S. W. ¼ of Sec. 12, T. 99, R. 40, is a steep ridge of unequal height and irregular form, about 500 feet long, tending S. 50° E., composed of very pebbly gravel, or perhaps till, with a few boulders, 1 to 3½ feet in diameter, scattered upon its sides and top. It rises 50 or 60 feet above the average of its region, and about 125 feet above Ocheyedan creek. Though so small it is the most conspicuous elevation of Osceola county. It is estimated to be 1,650 feet above sea, but upon exact determination it may be found to exceed this and be the highest land in Iowa, a distinction which has been erroneously assigned, with an exaggerated height, to the hills near Spirit lake. Southern and western Osceola, south-western Dickinson, much of O'Brien, western Clay, and north-western Buena Vista counties, lying next

beyond this moraine, are overspread with a smooth, slightly undulating sheet of till, at least from 100 to 200 feet in depth, as shown by the deep valley or channel of the Little Sioux river, and by wells which nowhere penetrate to the underlying rock. Farther south-west this deposit is concealed beneath the loess, which extends from the Missouri river 60 miles east to Storm lake and 75 miles north to Luverne.

THE COTEAU DES PRAIRIE.

A large area in southwestern Minnesota and eastern Dakota has an elevation from 500 to 1000 feet above the Minnesota river, and from 1300 to 2000 feet above the sea. Upon this highland district are the sources of Lac qui Parle, Yellow Medicine, Redwood and Cottonwood rivers, tributary to the Minnesota river: of the Des Moines river, and of the Little Sioux and Big Sioux rivers, tributary to the Missouri. The outer belt of the terminal moraine forms the highest portion of this area, and extends in Minnesota from southeastern Nobles county in a nearly north-northwest course, passing west of Worthington, through southwestern Murray county, the northeastern township of Pipestone county, and southwestern Lincoln county, by the west ends of lakes Benton, Shaokatan and Hendricks, into Dakota, where it continues in the same course through Deuel and Grant counties and the Sisseton and Warpeton Indian reservations. It thus reaches past the sources of the Big Sioux river, and farther northward becomes the divide between the head streams of the Minnesota river on the east and the James river on the west. This elevated tract, extending 200 miles, was called by the earliest French explorers the *Coteau des Prairies*, meaning the highlands of the prairies. This name, according to Nicollet, alludes to its conspicuous appearance, "looming as it were a distant shore," when viewed from the valleys of the Minnesota and James rivers, as is very noticeable from the vicinity of lakes Traverse and Big Stone, and from the highest points near the Minnesota river for perhaps 20 miles below Big Stone lake. Farther southeast this title was generally applied to the first prominent ascent above the broad, gently undulating expanse that reaches everywhere 20 or 30 miles from the Minnesota river. Before coming to this in going southwest, there is generally a very gradual slope, rising 100 or perhaps 150 feet in the last ten miles; then comes the steeper acsent which amounts to 200 or 300 feet within a width of two or three miles, coinciding through

the greater part of its extent across southwestern Minnesota with the tract of knolly and hilly drift that forms the inner belt of the moraine. The general height beyond, sometimes after a slight descent, continues to rise, but only slowly, amounting to 100 or 150 feet in crossing the smooth gently undulating area between this and the outer morainic range, which divides the waters of the Minnesota, Des Moines and Little Sioux rivers on the east from those of the Big Sioux river, and its tributaries on the west, forming, as already mentioned, the highest part of the Coteau des Prairies.

The inner line of hills of the terminal moraine extends from Spirit lake north and northwest through Jackson, Cottonwood, Murray, Lyon, Lincoln and Yellow Medicine counties, to Gary, where it enters Dakota, 11 miles west, northwest from Canby. From the west side of Spirit lake its course is north through Minneota, Hunter, Heron Lake and Delafield, the central range of townships in Jackson county. The width of this belt is from three to six miles. Its surface is prominently rolling, mostly in massive swells 20 to 40 feet above the depressions, but at many places in small, steep knolls and hillocks of similar height. The elevation of the range above the general level is from 30 to 50 feet. Its material is till, which here contains more gravel and boulders than on its smooth, slightly undulating areas which extend at each side beyong the limits of the county. The Des Moines river, east of this moraine, has excavated a valley 100 feet deep in this sheet of till, without exposing the bed rock; and G. C. Chamberlin's well at Jackson in this valley, went 130 feet in till with only thin beds of sand, not reaching its base at this depth, which is 100 feet below the river and 200 feet below the top of its bluffs. The railroad well at Heron Lake found the drift 186 feet deep, underlain by the red Pottsdam sandstone or quartzyte. In Minneota this morainic belt is about three miles wide, reaching from Little Spirit Lake and Clear lakes west to the Little Sioux river. It here has many knolls and short ridges which continue into Hunter, and are crossed 7 to 10 miles west of Jackson by the road to Worthington. Northwest from Jackson it is represented by the rolling tract about six miles wide, between the Des Moines and Heron Lake, west and southwest of which is a very flat expanse of till, 10 to 20 feet above the lake, stretching with slowly increasing height as far as the view extends westward.

In Cottonwood county this moraine continues north to the great bend of the Des Moines river, six miles northwest of Windom.

Thence its course is northwest through the north part of Springfield, northeastern Southbrook, southwestern Amo and Rose Hill. Its most conspicous portion and most roughly broken contour are in the Blue Mounds, which lie three miles west of Windom. This group or range of hills, composed of till with frequent boulders, extends three miles in a northwest course, parallel with the Des Moines river on the northeast, and Spring Lakes on the southwest. Their height is 100 to 150 feet above the river and 50 to 75 feet above the general level at their west side. Beyond the Blue Mounds this inner morainic belt is crossed by the Des Moines, which here flows eight miles northeast, at right angles with the rest of its course. Thence to Lake Shetek this belt is a prominent rolling tract several miles wide, rising about 100 feet above the river, and interspersed with lakes. The Des Moines river lies within a few miles at the southwest, being nearly parallel with the moraine; as it is also, but on the opposite side below this bend. East of Windom, a part of this formation, consisting of irregular hillocks of till with enclosed hollows and lakes, occupies a width of two or three miles, and forms the ascent of 75 or 100 feet above the Des Moines river, to a higher, smooth and nearly flat expanse of till, which thence extends 75 miles eastward, descending with an imperceptible slope to the Blue Earth river, and beyond this, rising in the same manner to the eastern series of this curved moraine at the sources of the Le Seuer and Cannon rivers, where Nicollet called it "the N. E. prong of the Coteau des Prairies." The hilly tract mentioned east of Windom appears to be part of a medial moraine branching from the terminal series on the west and extending north through the two western ranges of sections in Lakeside and Carson. Its most broken portion is found in Secs. 17, 8 and 5, Carson, which have many small hills and ridges 40 to 75 feet high, mostly trending from north to south, composed of till with abundant boulders. Ten miles farther north an isolated morainic area is found in Stately, the southwest township of Brown county, reaching from the elbow of Mound creek six miles west into the edge of Germantown in Cottonwood county, with a width of three to four miles, bounded on the north by the Cottonwood river. It is crossed by the lower paft of Mound creek, so named because of its mounds, ridges and hills of till, which are 25 to 75 feet high, abrupt and strown with boulders and pebbles. Between these areas of small drift hills in Carson and Stately is a massive ridge of red Pottsdam quartzyte, which extends 25 miles from west to east through Storden, Amboy, Delton and Selma, in northern

Cottonwood county, terminating in the west edge of Adrian, the northwest township of Watonwan county. This highland is mostly covered by a smooth surface of till, but has frequent exposures of the rock. Its altitude increases from 100 feet at its east end to 250 feet westward above the broad, slightly undulating sheet of till which covers the region at its north side, excepting the morainic tract in Stately, and reaches 25 miles north to the Minnesota river. The height reached at the top of this quartzyte ridge, from 1300 to 1400 feet above the sea, is a peramnent rise of the land which southwestward holds nearly this average elevation to the Des Moines river.

In northeastern Murray county the inner morainic belt, two to four miles wide. extends from Lake Eliza northwest by Duck and Buffalo lakes and the northeast side of Lake Shetek, occupying the northeast part of Des Moines river township, southwestern Dovray, northeastern Murray, the southwest half of Shetek, and the northeast part of Lake Sarah. It is distinguished from the slightly undulating areas of till at each side by its more frequent boulders and its more rolling and occasionally hilly contour; but it scarcely anywhere exhibits the rough surface which characterized the greater part of this series of drift accumulations. The crests of its swells are thirty to forty feet above the intervening depressions, sloughs. and lakes; nearly the same above the general level on each side; and from 75 to 100 feet above the Des Moines river and 40 to 50 above Lake Shetek. The only part of the series in this county which rises in mounds that are conspicuously seen at a distance of several miles is in the northeast corner of Murray township, upon an area from one-half to one mile wide, extending two miles northwesterly from Buffalo lake; but its hills here are only 30 to 50 feet above the average height of the range. Along the northeast side of the northwest area of Lake Shetek, commonly called the "Inlet," are frequent small patches where boulders nearly cover the ground, mostly forming knolls from 3 to 5 or 10 feet high, and occurring from the lake shore to 25 feet above it.

The inner terminal moraine east of Lake Shetek and in Lyon, Lincoln and Yellow Medicine counties forms the northeast border of the Coteau des Prairies, which has a width of about twenty miles, its southwest border being the outer and more prominent terminal range of drift hills which extends by the west ends of Lakes Benton, Shaokatan and Hendricks. From the Blue Mounds in southern Cottonwood county to Gary in the edge of Dakota, the

course of the inner series of this formation is northwest and nearly straight. In Lyon county its northeast boundary passes through the center of Custer, Lyon and Island lake townships, and follows approximately the line between this and Lincoln county, for the next six miles at the west side of Nordland. It crosses northeastern Lincoln county from the southeast corner of Altavista to section 3, Marble, six miles south of Canby; and in Yellow Medicine county its course is from section 33, Norman, to section 7, Florida. The most rough and hilly part of this morainic belt is from ½ to 1½ miles wide at its northeast side, where it usually has many irregular knolls, short ridges, and hills, which rise from 25 to 50 feet, and occasionally 75 to 100 feet above the intervening depressions. Their conspicuous appearance, as seen from the northeast, is due to the ascent westward of the country upon which they lie. The Coteau des Prairies, in these inner and outer series of drift hills and upon its intervening tract of smooth or moderately rolling land, has no exposures of the bed rock, but the elevation of this highland is doubtless caused by the altitude of the underlying rock surface, upon which the drift has been deposited as a sheet which is commonly from 100 to 200 feet thick throughout the western two-thirds of Minnesota. From the specially hilly northeast margin of this morainic belt its width reaches five to fifteen miles southwestward with a rolling and in some places knolly or hilly surface, including the greater part of the distance to the parallel outer range of drift hills, but leaving next to that a smooth slighly undulating tract, three to five miles wide. In Marshfield and Lake Stay (Ts. 110 and 111, of R. 44) this smooth contour extends eight miles north from the Cottonwood lake (dry during the last two or three years,) and the east end of Lake Benton, its limit being here twelve miles from the outer moraine. All these areas are till, with many boulders upon the portions which are most broken by knolls, hills and hollows.

The Antelope Hills and Valley. A third well marked series of low broken hills and ridges of till, with abundant large and small rock-fragments, is found in Yellow Medicine and Lac qui Parle counties, lying 8 to 12 miles northeast from the inner morainic belt of the Coteau, and extending north, northwest 40 miles within the limits of Minnesota. The width of this morainic series is usually from one-fourth to one-half mile, being less than that of the specially knolly belts upon the Coteau des Prairies. It appears like them to be a terminal moraine ; and its location shows that it was accumulated after a second retreat of the ice-border. The

slight readvance by which these hillocks was heaped at its termination seems not to have occurred generally to other portions of the ice-sheet; at least a corresponding third distinct moraine has not been noticed by me elsewhere. This formation begins in sections 32, 29 and 19, of Burton (T. 114, R. 43), in Yellow Medicine county; continues through sections 13, 11 and 3, of Vergeland (T. 114, R. 44), with similar outlaying hillocks and ridges in sections 9, 15, 16, 21, 22 and 23, of this township; and for the next six miles northward, lies in the southwest edge of Oshkosh and the northeast edge of Hammer. In Lac qui Parle county this moraine forms the two conspicuous clusters of the Antelope hills. in sections 27 and 16, Freeland (T. 116, R. 45), elevated 40 to 100 feet above the smoothly undulating till of their region. Its continuation runs from section 32, T. 117, R. 45, in a nearly straight course to section 33, T. 119, R. 46. One of its hills, about 60 feet high, at the north side of the west branch of Lac qui Parle river, in section 18, T. 117, R. 45, has been named Mt. Wickham. Thence for five miles northerly this knolly belt, 10 to 40 feet above the general level on each side, is known as the Stony Ridge. In T. 119, R. 46, the range seems to be offset three miles to the northeast, from section 33 to section 14, and thence it extends west, northwest to the State line. In the east edge of Dakota these accumulations rise prominently in the fractional T. 120, R. 47, and are called Yellow Bank hills, from the river of this name which here flows through them. Mt. Tom, their highest point, in or near the N. E. $\frac{1}{4}$ of section 32 of this township, has an elevation of about 100 feet. A belt of rolling land, about three miles wide, higher than the more gently undulating areas on each side, continues from these hills northwesterly across Grant county and into the Sisseton and Warpeton reservation, lying within six miles ~~nor~~southwest of Big Stone lake, and having its east side at about the same distance west of Brown's Valley.

Between this morainic belt and the foot of the Coteau on the west is the Antelope Valley, so named by the Sioux. This is a broad shallow depression, with a slightly undulating surface of till, being from three to ten miles wide, and reputed to extend 125 miles, from the northwest township of Lyon county in Minnesota to the south bend of the Sheyenne river in Dakota. The moraine of the Antelope hills and the smooth area of till on its east side average 25 to 50 feet higher, but have some lower portions, allowing streams to cross the Antelope Valley transversely; and next

to the west the Coteau rises about 700 feet within ten or fifteen miles.

The outer or western moraine belt of the Coteau des Prairies extends into the south edge of Minnesota along its course of 20 miles, next west from Spirit lake, where the greater part of its width lies in Iowa. From the Little Sioux river at the west side of Minnesota in Jackson county, to Indian lake in southeastern Nobles county, the width of this formation in our state is from 1½ to 5 miles, reaching north to Skunk lake, to ½ mile beyond Rush lake, to Plum Island and Round lakes, and to the north end of Indian lake. Its greatest extent north in this distance is at the north side of Round lake; but south of this a tract about two miles wide and three miles long to the east from State Line lake, is smooth and only slightly undulating, though enclosed by rolling or knolly morainic areas.

In its northwestern course across Nobles county this belt has a width of about five miles to the center of the county and Summit lake, including the southwest part of Indian lake, nearly all of Bigelow, the northeast edge of Ransom, southwestern Worthington, the northeast half of Dewald, and the south half of Summit lake, with a spur extending north through sections 14, 11, and 2, of the last named township. Onward in T. 103, R. 42, and in the west half of Willmont, its width diminishes from three or four miles to about one mile. Its contour through Nobles county is prominently rolling in swells that trend approximately from southeast to northwest, and rise 50 to 75 feet above the smooth, slightly undulating area next northeast, which extends thence with an imperceptible descending slope northeastward 20 miles to the inner moraine beyond Heron lake and the upper part of Des Moines river. Westward the surface is in swells which trend mostly from north to south, more massive and smoother than those which form the outer terminal moraine, and of about the same elevation; or in nearly level, equally high plateaus; as at Rushmore, 10 miles west of Worthington, and in the southwest part of Little Rock. The material of Nobles county is nearly everywhere till or boulder-clay; excepting the plain with a subsoil of gravel and sand, which occupies the southern two thirds of Grand Prairie, its southwest township, surrounded by swells of till 40 to 75 feet higher.

In western Murray connty and northeastern Pipestone county the outer moraine rises in a conspicuous series of drift-hills, which continues thence 150 miles north-northwest as a belt of very knolly and hilly drift from one to five miles wide, to the head of

the Coteau des Prairies, west of Lake Traverse. Throughout this distance its material is till with abundant boulders and pebbles, principally of granite, syenite, gneiss and schists, but also including many of limestone. Its surface is broken by a multitude of mounds, short ridges and hillocks, from 10 to 50 feet above the hollows which occasionally contain sloughs and lakelets. From Murray county to the center of Deuel county in Dakota, west of Gary, this morainic belt form a range 50 to 100 feet above the smooth till at its west side which is either in massive swells, as generally in Pipestone county, or farther north, in slightly undulating and often nearly flat slopes which descend westward to the Big Sioux river. At the east side of this range gently undulating till from 100 to 200 feet covers an area 15 to 20 miles wide, in central Murray county, and a narrower belt through Lyon county, reaching to the borders of the inner moraine. In northern Deuel county and northward through Grant county to the source of the Big Sioux river, the two morainic series lie nearer together, and the three or four miles intervening between their roughest belts have a rolling and in some places knolly surface, which rises 75 or 100 feet per mile westward to the west side of the outer moraine. Through this distance and north to the head of the Coteau des Prairies this ascent reaches an elevation about 1000 feet above the Minnesota river and Big Stone and Traverse lakes. Though no exposures of the bed-rock have been found upon this highland, it is believed to rise here much higher than in the valley sof the Minnesota, Big Sioux and James rivers at each side. The altitude of the Coteau is probably thus caused by the greater height of the rock upon which these drift deposits lie, rather than by their extraordinary thickness beyond that which they commonly have throughout southwestern Minnesota. The depth that is added to the general drift-sheet by the accumulations of the terminal moraine does not appear to average more than 50 to 75 feet; and its highest hills found in the exploration of this formation through Minnesota, Iowa and southeastern Dakota, very seldom exceed a height of 100 or 150 feet above the general level of the country. The only tract of considerable extent where they attain a greater elevation is the Leaf hills in southern Otter Tail county, which, for a distance of 25 miles, are from 100 to 350 feet high. Upon the most prominent portion of the Coteau des Prairies extending from Deuel county northward, the knolls and hillocks of this moraine rise 20 to 50 and rarely 75 feet above the adjoining hollows; and the thickness which it adds to to drift-sheet appears to be from 50 to

100 feet. That the prominence of this highland is not due to these morainic accumulations is shown by the greater elevation that is reached within from two to five miles distance by the smooth sheet of till at its west side, which forms the watershed, and beyond decends to the Big Sioux river.

The outer moraine in Murray county includes the west edge of T. 105, R. 42, being here from one-fourth of a mile to one mile wide, the south two-thirds of Leeds, the northeast two-thirds of Chanarambie, its most conspicuous portion in this county being Buffalo ridge, 100 to 150 feet high, trending from southeast to northwest, in sections 21 and 16 of this township; the west half of Cameron, and the southwest corner of Ellsworth. Its area in Leeds, extending six miles east from the main course of the series, and surrounded on the south, east and north by a lower expanse of smooth, slightly undulating till, may be a medial branch. Eight miles northeast from this, in sections 8 and 5, Mason, is a remarkable plateau of till, with its top nearly level, and covering 1½ square miles, from which there is a descent of about 200 feet in three miles east to Lake Shetek, and about 100 feet in the same distance west to Bear lakes.

In northeastern Pipestone county the morainic belt is about three miles wide, and extends through the northeast part of Rock, the center of Ætna and the northeast edge or Fountain Prairie. In Ætna, the northeast township of this county, it is quite picturesquely, broken in knolls and spurs, which rise gradually to a height of 100 to 150 feet above the land on each side.

In Lincoln county this moraine is about two miles wide, and extends north-northwest by the west ends of lakes Benton and Shaoakatan, passing through the middle of Lake Benton township, the southwest corner of Diamond lake, the center of Drammen and southwestern Shaokatan. Its height from its east edge is 100 to 200 feet, and from its west edge 40 to 75 feet. This morainic belt and the thick sheet of till which is massed against its west side and descends thence westward, are penetrated in the west part of Lake Benton township, by a deep channel or valley, which is called. translating its Sioux name, "The Hole in the Mountain." The railroad between Lake Benton and Verdi goes south-southwest four miles through this gap, bounded on each side by picturesque bluffs which are buttressed by steep spurs and cut by deep tributary ravines. Its depth, wholly in the glacial drift, is from 150 to 200 feet below the knolly surface of the moraine, and its highest point is about 15 feet above Lake Benton, which has its outlet eastward

into the Redwood river. This valley, from ⅛ to ¼ mile wide, was evidently excavated by a river that flowed from northeast to southwest across this great ridge, which is the highest land in southwesterm Minnesota, being 1000 feet above the Minnesota river at the northeast, 350 feet above the Big Sioux at the west, and about 1960 feet above the sea. For three-fourths of a mile southwest from Lake Benton, this channel is double, being divided by a remnant of the morainic range, which rises nearly as high as the enclosing bluffs. The east pass is called the "Dutchman's Gap," and through it the carriage road goes south and then southwest to the "Hole in the Mountain."

At three other places, 11, 14 and 18 miles northwest from Lake Benton (see map of this region on plate VI), similar channels have been noted through the massive ridge of this moraine and through the smooth sheet of drift that slopes downward from its west side. The first of these channels begins at the southwest end of Lake Shaokatan, and first extends about two miles southwest, in the same course with this lake, through the knolly belt of the moraine, beyond which its course for the next three miles is northwest along its west side, crossing the State line, from section 31, Shaokaton, to the east part of section 21, T. 111, R. 47. There it is joined from the northwest by the second of these channels, which enters the moraine in the southwest quarter of section 7, Shaokatan. This is the only one of these gaps through which the drainage now takes place, as at the time of their excavation, from the northeast to the southwest side of the morainic range. Bluffs 75 to 100 feet high form the sides of these valleys, enclosing a nearly flat bottom land which varies from 300 to 800 feet in width. Lake Shaokatan outflows northeastward to the Yellow Medicine river; but the highest part of the valley that extends from it southwest and then northwest, is only slightly elevated above it. The southwest course of the second channel is continued 2½ miles below their junction, having about the same depth and width, to the center of section 30, T. 111, R. 47, where it enters the last of these remarkable valleys. This lies wholly in Brookings county, Dakota. It extends six miles southward from the southwest end of Lake Hendricks, and then about a half mile beyond the confluence of the valley from Lake Shaokatan, it turns west-southwest. Its depth for the first two miles south of Lake Hendricks, where its bluffs are capped by the knolls and short ridges of the moraine, is from 150 to 200 feet. Along the remainder of its course to the mouth of the tributary channel, its bluffs ascend steeply about 100 feet, and from

their top a moderate slope rises 40 to 50 feet higher. Below this junction the valley slowly diminishes in depth, and after six miles reaches an area of low land in the northwest part of T. 11, R. 48, which stretches thence to the Big Sioux river. A nearly flat bottom land from 1-10 to ¼ mile wide extends from Lake Hendricks the entire length of this valley. Its highest part, 1½ miles from the lake, is about 15 feet above it, the outlet of this lake being northeastward to the Lac qui Parle river.

The channel which has been last described, running south from Lake Hendricks, was called by the Sioux "The Brother of the Hole in the Mountain," because of its close likeness to the pass south, southwest from Lake Benton. The west end of these lakes, for about a mile of each, are bordered by hillocks and high bluffs, and occupy the extremities of these channels at their entrance within the limits of the moraine. Lake Benton is six miles long and from one-half mile to a mile wide, its greatest width being at the northeast. Lake Shaokatan is about three miles long, and from one-eighth two three-fourths mile wide, its maximum width being near the middle. The southwest end of this lake is at the northeast edge of the morainic belt. Lake Hendricks is three and one-half miles long, and its width varies from one-fourth to three-fourths of a mile, being greatest near its northeast end. The maximum depth of each of these lakes is reported to be about 15 feet; and they are bordered on all sides excepting the west by smoothly undulating till, which varies from 10 to 30 feet, or rarely 50 feet, above them. Thus the hollows in which they lie sink about 40 feet below the general level of the drift-sheet at the east side of the morainic range, and about 30 feet below the highest part of these channels which are continuations from them through this moraine and the thick sheet of till at its west side. Nowhere else for at least 50 miles next to the northwest from Murray county is this massive ridge intersected by any similar channel, and its altitude throughout this distance is from 100 to 200 feet above these lakes. Its highest portion, forming a belt about two miles wide, marked by many hillocks and hollows, appears to have been pushed out at the margin of an ice-sheet that lay upon its northeast side. The excavation of these channels took place at the same time with the accumulation of this moraine, or more probably at the close of this part of our last glacial epoch, when the ice was being rapidly melted, but before it had receded to its inner line of moraine; for the thick mass of the ice-sheet, rising high above its terminal deposits, is the only barrier that we can

suppose to have existed to turn the course of drainage across this highland, which is now the watershed between the much lower broad basins of the Minnesota and Big Sioux rivers, and after this was withdrawn to its later limits at its inner moraine, extending from Spirit lake to Lake Shetek and Gary, a lower avenue was opened southward to the Little Sioux river. Without reference to this barrier, it is evident that the course of the waters that eroded these valleys was southwest, because of their extent and fall in this direction. The channel that reaches south from Lake Hendricks and then southwest descends from the summit, one and one-half miles south of the lake, with a very gradual slope which probably amounts to 75 or 100 feet in the next ten miles, its width continuing nearly the same as where it intersects the moraine. Another proof that the course of drainage was southwest is the confluence in this direction of the three valleys that cross this range at Lake Shaokatan, three miles farther northwest, and at Lake Hendricks.

On the other side of the moraine no well marked valleys extend northeastward from the lakes; and their outlets, which run only at unusually wet seasons, are turned in a meandering course by slight undulations of the surface. There seems to be no indication that the channels through the moraine have become partially filled since their excavation, raising them to their summits, 15 feet more or less, above Lakes Benton, Shaokatan and Hendricks; while yet the position and form of these lakes demonstrate that the portions of the drift-sheet which would have filled their depressions, were carried away by the rivers that cut these gaps. Now it is clear that the overflow from a lake lying between the ice-sheet and its moraine could not excavate a hollow several miles long below a summit which it afterward crossed. Respecting the possible action of subglacial rivers we have little knowledge, but it appears improbable that they could erode such hollows, carrying the material forward through higher channels. It is, however, nearly certain that this removal of the drift belonging upon the areas occupied by these lakes took place while the ice-sheet still covered these areas and reached to its terminal moraine; but near the end of this time when a warmer climate was rapidly melting its surface every summer, pouring down large rivers to its margin. By such melting, the drift which had been gathered into the ice-mass would become exposed upon its surface, and in and near its principal avenues of drainage would be washed away. Only in this manner could the material of the drift-sheet corresponding to the depressions of

these lakes, be removed by the usual agency, that is, by the current of descending streams. If this be the true explanation, it involves a very important conclusion respecting the amount of drift contained in the ice-sheet and finally exposed by the melting of its surface. Modified drift and kames, as also certain features of the till and of the terminal moraines, prove that the ice of the glacial period became considerably filled with the material of the drift, gathered up into its mass from the land over which it moved.

Our last explanation of the origins of these lake basins indicates that the ice-held drift here amounted to a sheet at least 40 feet thick; but much of it may have been in the lower 150 feet of the ice, below the top of its terminal moraine.

In Dakota the continuation of this outer belt of knolly and hilly drift has been traced north-northwest through northeastern Brookings county, the center of Deuel county, southwestern Grant county and the northeast corner of Codington county. Its width is from two to three miles. North from Gary the nearly parallel inner moraine, very roughly broken upon a width that varies from one to two miles, is divided from this western moraine, as was stated on a preceding page, by a width of three or four miles which has a rolling surface but is much smoother in its outlines and slopes than these specially knolly belts. The inner or eastern moraine is generally from 100 to 200 feet above the foot of the slope on which it lies. This ascends some 250 feet more in the interval between this and the outer or western moraine, which lies between about 500 and 650 feet above the base of this slope, and approximately between 800 and 950 feet above the Minnesota river and Big Stone Lake. At the west side of the outer moraine in northern Deuel county and northward after a descent of 20 to 40 feet a smooth surface of slightly undulating till succeeds, and within a few miles rises 30 to 50 feet, and in some portions 75 feet, above the highest hillocks that were heaped at the margin of the ice-sheet, this watershed being from 1000 to 1050 feet above the Minnesota river or about 2000 feet above the sea. The material of these moraines is till with many boulders; and their contour is as usual, in many small hills, ridges and irregular hollows.

The outer moraine crosses northeastern Brookings county from sections 15 and 16, T. 111, R. 47, to sections 1 and 2, T. 112, R. 48. The southwest end of lake Hendricks and Oak lake lie in the east part of this belt. In Deuel county it first extends north through the east third of Ts. 113 and 114, R. 48, and thence passes northwestward to the county line at the north side of sections

1, 2, and 3, of its northwest township. Clear lake, the Coteau lakes, and the North Two Woods lakes lie at its west side, the last being in the depression between this belt of drift hills and knolls and the higher smooth surface of till three miles farther northwest. In crossing Deuel county from east to west on the Winona & St. Peter (C. & N. W.) railroad, the traveler enters the inner morainic belt at the west edge of Minnesota, a little east of Gary. This line crosses this belt obliquely, occupying about four miles;
then six miles are moderately rolling, mainly in smooth swells;
and the next six miles, lying partly on each side of Altámont, are among the knolls and small hills of the outer moraine, succeeded by a smooth, slightly undulating area of till, which rises to the summit of this line near Goodwin, 2000 feet above the sea, extends thence nearly level to Kranzburg, and then descends 250 feet by a very gradual slope to Watertown. Several lakes occur between these moranic belts in Deuel county, the largest being Lake Alice, two miles north of the railroad.

In southwestern Grant county and the northeast corner of Codington county, the west border of the outer moraine extends from section 34, T. 118, R. 50, to the southwest corner of section 30, T. 119, R. 50, and thence passes more westerly to sections 36 and 25, T. 120, R. 52. A lake two miles long lies at the southwest side of this knolly belt in T. 118, R. 50, and Punished Woman's lake lies within its limits seven miles farther northwest, in the northeast township of Codington county. The line of inner moraine in Grant county reaches from section 31, T. 118, R. 48, northwesterly to sections 33 and 34, T. 120, R. 50.

The farther extent of this formation forty miles north-northwest to the head of the Coteau des Prairies, twenty-five miles west of Lake Traverse, has not been explored. The land on which it lies is conspicuously seen from the east, as it maintains a continuous height about 2000 feet above the sea, or 1000 feet above Big Stone lake, Brown's valley, and Lake Traverse. Within a few miles north from the head of the coteau, the land in the northwest part of the Sisseton and Warpeton reservation falls 600 feet to the lowest portion of the watershed between Brown's Valley and the Sheyenne river.

THE MEDIAL MORAINE FROM THE HEAD OF THE COTEAU DES PRAIRIES TO TURTLE MOUNTAIN.

It seems quite probable that a morainic belt of knolly and hilly drift, several hundred feet lower than this most elevated north-

western portion of the Coteau des Prairies, continues in the same north-north-west course between the Sheyenne and James river, or in part east of the Sheyenne, to the Devil's lake (Mini-wakan), a distance of 175 miles. Nicollet crossed the area between these rivers near latitude 46°, 30, about 60 miles northwest from the head of the coteau, and remarks that its highest portion "may be considered as a continuation of the Coteau des Prairies." He states that in approaching Devil's lake from the southeast, on the east side of the Sheyenne river, the highest of the hills at its south side, called by the Sioux *Mini-wakan-chante*, "the heart of Devil's lake," could be seen at a distance of more than thirty miles. "The lake is on the plateau of the Shayen-oju [Sheyenne river], and is surrounded by swells and hills, varying in height from twenty to 250 feet........The lake itself is so filled up with islands and promontories, that, in traveling along its shores, it is only occasionally that one gets a glimpse of its expanse."*

Turtle Mountain, which is crossed by our national boundary 75 to 100 miles northwest from Devil's lake, appears to be a portion of the same morainic series. Of this "Mountain" Mr. George M. Dawson writes: "It is a broken, hilly, wooded region, with an area of perhaps twenty miles square, and slopes gradually upward from the plain around it, above which it is elevated, at its highest points, about 500 feet. .... Nearly all the abrupt slopes and ridges in Turtle mountain—of which there are many—show boulders in abundance, and these appear to be chiefly of Laurentian rocks. .... The western is more abruptly hilly than the eastern side, and the more prominent ridges have a general northerly and southerly direction with intervening valleys characterized by swamps and lakes. Large areas of comparatively level, or only gently undulated ground, are however found in some places. The surface of the 'mountain' appears to be that of the drift, as deposited, and has been but little modified by subsequent sub-aerial action. The lakes lie in basin-like hollows, and notwithstanding their great number, drainage valleys and stream courses are few and unimportant."†

Capt. W. J. Twining says: "From Turtle Mountain to the southeast, there is a series of rough hills, with intervals of rolling prairie, extending to Devil's lake, and thence to Lake Jessie, forming with the Coteau of the Prairie, on the western border of Min-

*Nicollet's Report on the upper Mississippi river, 1843; pp. 47 and 50.

†Dawson's *Report on the Geology of the Forty-ninth Parallel*; Montreal: 1875; pp 223 and 224.

nesota, a line of drift formation almost exactly parallel and similar in character to the Coteau of the Missouri."*

The principal masses of morainic drift which are found rising in prominent hills in or near the line of continuation of this formation to the north and northwest, occur in ranges which extend from east to west or from northeast to southwest. These include the Blue hills, stretching about 75 miles east from the lower part of the Souris or Mouse river, and the ranges of the Little Touchwood hills and the Touchwood hills north, of the Qu'Appelle river. Of the last Prof. H. Y. Hind writes: "The general direction of the range is N. 26° E. It appears to consist of a series of drift hills, many of which rise in rounded dome-shaped forms from the summit plateau," which is stated to have a width of four miles and an elevation about 500 feet above the prairie on the west, while its highest point, Heart hill, is some 700 feet above the plain eastward.†

If any of these morainic deposits northward from the head of the Coteau des Prairies were accumulated at the same time with the outer terminal moraine, which crosses southwestern Minnesota, they must be of medial origin, having been heaped where converging ice-currents were pushed against each other from the northeast and northwest, belonging to two vast lobes of the ice-sheet. The U-shaped moraine gathered at the margin of that which lay on the east, has been already described. It reaches from the head of the Coteau and from the Leaf hills south to central Iowa. The contemporaneous terminal moraine that marks the border of the second of these ice-lobes, lying on the west, extends from the head of the Coteau des Prairies about 150 miles southward on the west side of the Big Sioux river, then bends west across the lower part of the James river, and beyond turns to the north-northwest and northwest, crossing Dakota diagonally between the James and Souris rivers on the east and the Missouri river on the west, where it forms the conspicuous belts of knolly and hilly drift of the Coteau du Missouri.

THE TERMINAL MORAINE FROM THE HEAD OF THE COTEAU DES PRAIRIES TO THE COTEAU DU MISSOURI.

The course of the moraine accumulated at the east border of this western lobe of the ice-sheet has been mapped for me in Codington

*Report upon the Survey of the Boundary of the United States from the Lake of the Woods to the Rocky Mountains, 1878; p. 62. 8 - - 62

†Hind's *Report of the Assiniboine and Saskatchewan Exploring Expedition*; Toronto: 1859; p, 68.

and Hamlin counties by Mr. C. C. Wiley, land agent at Watertown, Dakota. He describes the formation in these counties as averaging about one mile in width, its material being till with abundant boulders, and its surface broken with many short ridges and hillocks, very irregular in their arrangement and variable in height, the most conspicuous being about 100 feet above the adjoining country. In general features this belt of hilly drift west of the Big Sioux is stated to be nearly the same with the morainic belts, which are crossed in Deuel and Grant counties, in going from Watertown east to Canby, or northeast to Big Stone City and Ortonville. The peculiar knolls and small hills of these moraines are almost universally called "coteaus;" and the belts occupied by them are very noticeable and unmistakable because of their rough topography and inferior agricultural value, in comparison with the smoothly undulating sheet of till which covers the remainder and much larger part of this region. Mr. Wiley reports that this moraine enters Codington county from the Sisseton and Warpeton reservation at the north, in the west edge of T. 119, R. 53, passing Indian lake, rising most prominently at the west side of section 31 of this township, and continuing two miles farther to the lake at the south side of Sec. 7, T. 118. R. 53. Through the next three or four miles this formation is inconspicuous, but regains its usual rough contour in Secs. 35 and 36 of T. 118, R. 54, and thence extends with a course a little east of south to the west ends of Lake Kampeska and Pelican lake, and thence south 3½ miles to the north line of Hamlin county. Its highest elevations occur is Sec. 13, T. 117, R. 54, one to two miles north of the west end of Lake Kampeska; south of this lake, in Secs. 5 and 6, T. 116, R. 53, lying six miles west of Watertown, and in the S. E. ¼ of Sec. 19 of the same township. From Sec. 13, T. 117, R. 54, a branch series of the drift hills extends three miles west and then seven miles northwest, bordered by several lakes on each side and ending in Secs. 26 and 23, T. 118, R. 55, at the west side of the largest of these lakes. The road from Watertown to the James river follows nearly the course of this range, which may be a medial moraine. In Hamlin county the course of this formation is first southeast through Secs. 4, 10 and 14, T. 115, R. 53, then south from section 23 of this township to Sec. 26, T. 114, R. 53, next south-southwest about three miles, and lastly south-southeast five miles, lying at the east side of three lakes, in T. 113, R. 53, and reaching the county line at the southeast corner of this township, at the southwest end of Lake Poinsett.

Southward the peculiar "coteaus" of this formation continue, as described to me by various travelers, in a course a little to the aast of south about 40 miles, with a width of from two to five miles, passing a few miles east of Nordland in southwestern Brookings county, through the northeastern border of Lake county, and into southwestern Moody county. Thence the series appears to bend southwest and west through the northwest edge of Minnehaha county. A range of these drift hills which is reported in T. 106, R. 55, at the west side of Lake county, is probably of medial origin. Of the farther course of this moraine, perhaps south through McCook and Turner counties and the north part of Yankton county, no definite information has been obtained.

THE COTEAU DU MISSOURI.

At the west side of this great lobe of the ice-sheet, its terminal deposits constitute the most broken portion of the Coteau du Missouri, generally forming its line of watershed. A second morainic belt appears also to be described 30 or 40 miles further west, lying at a distance of ten miles, more or less, east from the Missouri river. A part of this formation extending about twenty miles north-northwesterly in northern Aurora county and southeastern Hand county, lying about 30 miles west of Huron, has been named the Wesington hills.

Nicollet crossed the Coteau du Missouri in a northeast direction from Fort Pierre to the James river near the south line of Brown county, about west of Ortonville. On this route, within a few miles from the Missouri, its bluffs rise about 500 feet, attaining a height between 1900 and 2000 feet above the sea. The upper portion of these bluffs and the surface thence all the way to the James river, is reported to be drift. About 15 miles east of Fort Pierre, in the vicinity of East Medicine Knoll creek, a morainic area appears to have been crossed, respecting which Nicollet writes: "It is to be remarked of the prairies of this region, that they present low, insulated hillocks, to which the Sioux apply the somewhat generic name of *re* or *pahah*, according as they are more or less elevated above the surrounding plain. . . . .

Before quitting the forks of East Medicine river we had made an ample supply of water and wood; a necessary precaution, for soon every appearance of running water disappeared. The green plains regain their uniformity. bounded only by the horizon, and presenting a smooth surface, without one sprig of grass higher than an-

other. The deep furrows made by the buffaloes in their migrating excursions from north to south and from south to north, are the only irregularities of the surface. However, as the direction of our route is towards the eastern border of the plateau, we could not help remarking that there the undulations of the prairie are shorter, their intervals deeper, and finally swell into hills of 80 to 100 feet in elevation. We had then reached the dividing ridge between the waters that empty into the Missouri and those that flow into the river Jacques" [near the northwest corner of Hand county, 40 miles northeast from the knolly tract first crossed]. "The mean elevation of this ridge above the sea, is 2,100 feet, and goes to 2,200 feet, if the mean height of the hillocks formed of the erratic deposit be taken into the estimate................A few miles farther east we reached the extreme verge of the eastern limit of the Coteau du Missouri, whence a most magnificent spectacle presents itself, extending over the immense hydrographical basin of the Tchan-sansan, or river Jacques [James],............ The basin of the river Jacques between the two coteauu" [in latitude 45° 15', near the south line of Brown county] "may be laid down as having a breadth of 80 miles, sloping gradually down from an elevation of 700 to 750 feet,"*

Prof. Cyrus Thomas describes the Coteau des Prairies as divided southward into two arms, of which the western "encroaches close upon the James river valley, about latitude 44° 15', where it ends; the other arm reaches southeast, passing down on the east side of the headwaters of Big Sioux and gradually fades out in the southwest corner of Minnesota...............The other plateau is the Coteau of the Missouri. This hugs the valley, and follows the course of the Missouri northward from Fort Sully" [15 miles below the mouth of the Cheyenne river] "to the great bend of the river near the mouth of the Yellowstone. Here it recedes and extends in a northwest direction into British Possessions, where it gradually fades out and is lost. It varies in width from thirty to fifty miles, and in height from 1,800 to 2,200 feet above the sea; but the surface is more irregular than that of the other coteau, portions of it rising as much as 200 feet above the general average. The general elevation corresponds very closely with that of the Coteau des Prairies, showing very clearly some relation between the two. On each are numerous small lakes, mostly impregnated, more or less, with saline matter, and at many points on each, boulders are quite plenty." †

*Nicollet's *Report on the Upper Mississippi*, 1843, pp. 44—46.
†*U. S. Geol. Survey of the Territory*, 1872, p. 294.

Dr. F. V. Hayden writes or the drift deposits, evidently morainic, which cover portions of southeastern Dakota, and of the Coteau du Missouri, as follows: "North of the Missouri river, from the Big Sioux river to Fort Clark" [40 miles north of Bismarck], "there are districts where one might walk for miles across the plains and over the hills, without stepping upon the ground, so closely paved is it with worn or partially worn boulders."*

On the line of the Northern Pacific railroad the Coteau du Missouri is composed of till with frequent boulders, and has a rolling surface with many lakes, but does not rise in prominent hills. Its height is from 1800 to 1900 feet above the sea, the James river on the east being 1400, and the Missouri river on the west, 1650.

Gov. Isaac I. Stevens traversed the Coteau du Missouri from the west side of the loop of the Souris or Mouse river in Dakota westerly to Fort Union at the mouth of the Yellowstone and west line of this territory. "The distanee from Mouse river to Fort Union, as traveled, was 118½ miles. The route crosses the Grand Coteau, a collection of high, stony and barren knolls, with great numbers of small ponds lodged between the hills. .... The general elevation is between 2,000 and 2,500 feet, and it descends again at the Missouri (Fort Union) 2,019 feet. ......:... The plateau between the Missouri and Mouse river, cannot be called simply a rolling prairie, though in detail resembling the hilly prairies noticed, although in a very exaggerated degree, having a general similarity of outlines, an absence of wood and rocks in place, boulders plentiful, ponds and marshes, if possible, more frequent; but the elevations are so much greater as to form considerable hills and ridges several hundred feet high, which become still more rugged on the approach to Fort Union, where they end abruptly on the level intervale of the Missouri."†

Mr. George M. Dawsan, geologist of the British Boundary Commission for establishing the line between the United States and British America from Lake of the Woods to the Rocky Mountains, gives an admirable description of this belt of roughly hilly drifts, where it passes beyond our national limits at the northwest corner of Dakota, 120 west of Turtle Mountain. "The Missouri Coteau is one of the most important features of the western plains, and is certainly the most remarkable monument of the glacial period now existing there. I have had the opportunity of examining more or

†Report of same, 1870, p. 174. These quotations are cited by Mr. G. M. Dawson, in connection with his description of the Coteau du Missouri in the vicinity of the 49th parallel

**Reports of Explorations and Surveys for a Railroad from the Mississippi River to the Pacific Ocean made in 1853-5*; 1860, Vol. xii, Book 1. pp. 84 and 85.

less carefully that portion of it which crosses the forty-ninth parallel, northwestward for a length of about 100 miles. On the parallel, the breadth of the Coteau, measured at right angles to its general course, is about 30 miles; and it widens somewhat northward. On approaching its base, which is always well defined at a distance, a gravel ascent is made, amounting in a distance of 25 miles to over 150 feet. The surface at the same time becomes more remarkably undulating, as on nearing Turtle Mountain from the east, till almost before one is aware of the change, the trail is winding among a confusion of abruptly rounded and tumultuous hills. They consist entirely of drift material; and many of them seem to be formed almost altogether of boulders and gravel, the finer matter having been to a great extent washed down into the hollows and basin-like valleys without outlets with which this district abounds. The ridges and valleys have in general no very determined direction; but a slight tendency to arrangement in north and south lines was observable in some places. .... Taking the difference of level between the last Tertiary rocks seen near the eastern base of the Coteau, and those first found on its western side, a distance of about 70 miles, we find a rise of 600 feet .... On and against this gently inclined plane the immense drift deposits of the Coteau hills are piled. The average elevation of the Coteau above the sea, near the forty-ninth parallel, is about 2,000 feet; and few of the hills rise more than 100 feet above the general level. .... From what I can learn of this region it would appear that the so-called Coteau des Prairies and Coteau de Missouri, between which a distinction is made on the maps, are parts of the same great feature. Their elevation is similar, and nearly the same as that of the Coteau on the line; and they are equally characterized by the immense profusion of erratics with which they are strewn, and by basin-like swamps and lakes. The Coteau des Prairies, however, stretches furthest, and dies away only in the southwestern corner of Minnesota. In the Coteau, then, we have a natural feature of the first magnitude, a mass of glacial debris and traveled blocks, with an average breadth of perhaps 30 to 40 miles, and extending diagonally across the central region of the continent for a distance of about 800 miles."

In British America, between the 49th and 50th parallels, a plateau of Tertiary strata, higher than these drift deposits, rises at their southwest side, its slope near the border of the Coteau being characterized by lakes or chains of lakes, which "have a winding river-like form, and fill steep-sided valleys. These great old valleys have

now no outlet; they are evidently of preglacial age, and have formed a part of the former sculpture of the country. The heaping of the great mass of debris of the Coteau against the foot of the Tertiary plateau has blocked them up and prevented the waters from finding their way northward as before ; and since glacial times the rainfall of the district has never been sufficiently great in proportion to the evaporation to enable the streams to cut through the barrier thus formed. The existence of these old valleys, and the arrangement of the drift deposits with regard to them, throw important light on the former history of the plains. Northward the Coteau ceases to be identified with the Tertiary plateau, and rests on a slope of Cretaceous rocks. It can be followed by Palliser's and Hector's descriptions of the country to the elbow of the South Saskatchewan, and thence in a line nearly due north through the Eagle and Thickwood hills" [the former lying at the west side of the South Saskatchewan below its elbow, and the latter north of the North Saskatchewan, about 75 miles west of the junction of these rivers and 300 miles west of Lake Winnipeg]; "beyond the North Saskatchewan, however, it appears to become more broken and less definite. In Dr. Hector's description of certain great valleys without outlet in this northern region, I believe I can recognize there too the existence of old blocked-up river-courses similar to those just described."*

It appears that north of latitude 50° this formation consists, as in Freeborn county and upon the Coteau des Prairies in southwestern Minnesota, of two nearly parallel ranges or belts of knolly and hilly drift. Besides this series of drift hills of Dawson's report and map, west of the South Saskatchewan river, or South Branch, between its elbow and its confluence with the North Branch, another morainic belt occurs at its east side along this distance, of which Prof. H. Y. Hind writes as follows: "A continuation or spur of the Grand Coteau comes on the Qu'Appelle river at the height of land about 18 miles [east, southeast] from the elbow of the South Branch. Here it is called the 'Eyebrow Hill Range' by the Crees. .... The South Branch flows for fully 200 miles from the elbow at the foot of this continuation of the Eyebrow Hill Range, in a northerly direction, and its deep excavated valley appears to lie at an average distance of twelve miles from it. This range is cut by several narrow deep valleys ; and from the small lakes or ponds which occupy their summits,

* G. M. Dawson, in *Quarterly Journal Geol. Soc.*, for Nov., 1875, vol. xxxi, pp. 614—616 ; and more fully in *Rep. on Geol.* on the Forty-ninth Parallel, 1875, pp. 227—237.

water, during spring freshets, flows to the Saskatchewan and Assiniboine. .... It appears to terminate suddenly in the form of an isolated hill about 400 feet above the plain, called 'The Lumpy hill of the Woods.' .... From its summit an undulating open country, dotted with lakes and flanked by the Birch hills is visible towards the east. South and southwest is a lake region, also north and northeast. These lakes are numerous and large, often three miles long and two broad. Seventeen large lakes can be counted from the Lumpy Hill; hill ranges in several directions can also be discerned. The most important of these are the Bloody hills, the Woody hills, far in the prairie west of the South Branch, and the chain of the Birch hills running from the Lumpy hill [north-]easterly. .... This eminence consists of drift sand and clay, with boulders on its summit."*

The origin of the morainic range of the Touchwood hills, briefly described on a preceding page, seems very probably to have been as a medial branch about 150 miles in length, diverging northeasterly from the Coteau du Missouri at about 40 miles south of the Eyebrow hill and the head of the Qu'Appelle river. Twenty-five miles east-southeast from the Eyebrow hill, the Qu'Appelle intersects this belt of drift hills at the head of Buffalo Pound Hill lake. Prof. Hind says: "The whole country here assumed a different appearance; it now bore resemblance to a stormy sea suddenly become rigid; the hills were of gravel and very abrupt, but none exceeded 100 feet in height. The Coteau du Missouri is clearly seen from Buffalo Pond Hill towards the south, while northeasterly the Last Mountain of the Touchwood Hill range looms gray or blue in the distance. Between these distant ranges a treeless plain intervenes."†

THE BLUE HILLS AND THE MESABI RANGE.

The Blue hills of the Souris, extending 75 miles east from the northwest side of the Souris or Mouse river near its mouth, about 30 miles north of Turtle Mountain, to the escarpment called Pembina mountain, which forms the west boundary of the plain of the Red river valley, appear to be part of a terminal moraine, accumulated at the front of the ice-sheet during a halt in its retreat, perhaps attended by some readvance, long after it had withdrawn from the Coteau of the Missouri and the Coteau of the Prairies.

* *Report of the Assiniboine and Saskatchewan Exploring Expedition*, 1859; pp. 27, 28, 67 and 68.
†Same report, p. 53.

The Mesabi range of drift hills in northern Minnesota,* reaching from Winnebigoshish and Bowstring lakes easterly to the sources the St. Louis and Vermilion rivers, and thence east-northeast upon a region which has frequent exposures of the bed-rocks, sometimes in more conspicuous hills than those of the drift, is believed to be another part of the terminal moraine. The topographic features of these series of drift deposits indicate this origin; and their geographic position makes it probable that they are contemporaneous with each other, and certain that they are more recent than the terminal moraine which extends from the coteau to Mineral Ridge in Iowa, thence northward to the Leaf hills in Minnesota, and from there east and southeast to the Kettle Range in Wisconsin. Professor Hind states that the Blue hills of the Souris are composed of drift derived chiefly from the Cretaceous rocks which underlie that region, and their height is marked on his map as from 50 to 500 feet, the valley that the Souris has cut through the range being 350 feet high.

MODIFIED DRIFT AND LOESS.

When the ice-sheet extended to the Coteau du Missouri, the Coteau des Prairies, and the Kettle moraine, the floods formed by its summer meltings were carried southward by the present avenues of drainage, the streams which occupied the areas between its great lobes in order from west to east being the Big Sioux, Mississippi, and Wisconsin rivers. The vast glaciers which were gathered upon the Rocky mountains, and the ice-fields which sloped downwards to their termination at the coteaus and the moraine north and east in Minnesota and Wisconsin, supplied every summer immense floods laden with silt, sand, and gravel, that had been contained in the melting ice. Very extensive deposits of modified drift were thus spread along the course of the swollen Missouri and Mississippi. The Orange sand and gravel, described by Prof. E. W. Hilyard and others in the lower Mississippi valley, appear to have been deposited in this way, but during the earlier glacial epoch when an ice-sheet reached in Dakota beyond the Missouri river to a termination 40 miles west and 20 miles southwest of Bismarck,† into northeastern Kansas, half way across the State of Missouri, and nearly to the Ohio river.

In the closing stages of this epoch and during the time succeeding till the date of the terminal moraine of the Coteaus and especial-

*Seventh An. Rept. Geol. and Nat. Hist. Survey of Minn. for 1878, p. 12; and Col.C. Whittlesey's Report on Mineral Regions of Minnesota, 1866, pp. 8 and 44.

†Prof. N. H. Winchell's Report to Capt. Ludlow, on *Geology of the Black Hills of Dakota*, 1875; pp. 22 and 60.

ly at the final retreat of the ice-sheet of this later epoch, the deposition of the overlying, finely pulverized, arenaceous and calcareous silt, called the Bluff formation or Loess, took place. This covers considerable areas along the Mississippi from southeastern Minnesota to its mouth; but its greatest thickness and extent are found in the basin of the Missouri river from southern Dakota to its junction with the Mississippi, and upon the region crossed by the Platte or Nebraska river, its longest tributary from the west, which takes its headwaters from a large district of the Rocky mountains. The continuity of this formation from the borders of the ice-sheet and the glaciers of the Rocky mountains to the shores of the Gulf of Mexico, the absence from it of marine shells, and the presence of land and fresh water shells, indicate that its deposition was by slowly descending floods, uplifted upon the surface of this sediment which was being accumulated during every summer through a long epoch, in the same manner that alluvium is now spread upon the bottom lands of our rivers at their times of overflow. The occurrence of the loess in Guthrie, Carroll, Sac, and Buena Vista counties in Iowa, covering the region next west of the terminal moraine, with its surface 50 feet above these drift hills and 100 feet above the undulating area of till adjoining their east side, proves that during the time of deposition of this part of the loess the ice-sheet extended to this limit and was a barrier preventing the waters by which this sediment was brought from flowing over the lower area of till that reaches thence east to the Des Moines river. When the the ice-sheet retreated beyond the watershed of the Missouri basin, the principal source of these floods and their sediment was removed, and the subsequent work of the rivers which cross the area of the loess has been to excavate their present valleys or channels, bounded by bluffs of this formation.

RECESSION OF THE ICE-SHEET.

The departure of the ice-sheet appears to have taken place by melting which affected large areas of its surface, causing the ice to disappear from wide districts without leaving upon them any deposits pushed out at its border or accumulated at lines where opposing ice-currents met. Anon a colder epoch causes the thickness and extent of the ice-fields to increase again, and another terminal moraine is formed at its margin. In Minnesota, Iowa, Dakota and British America, the first halt or readvance is marked by the inner morainic series which appears east of the South Saskatchewan; in the east belt of drift-hills upon the Coteau of

the Missouri; and, as traced by the writer, on the Coteau of the Prairies from Grant county in Dakota, through southwestern Minnesota, and at least to the south line of Palo Alto county in Iowa, and on the east side of this lobe of ice-sheet from Rice county in Minnesota, southward through Waseca, Steele and Freeborn counties in this State, and Winnebago, Hancock and Wright counties in Iowa. This inner moraine is from two to twenty-five miles distant from the outer approximately parallel moraine. The courses of drainage which were now taken by the waters that flowed from the ice-border were nearly identical with those of the present time on the east side of the great ice-lobe which reached from Minnesota to central Iowa. On its west side the drainage from the Coteau des Prairies, between the morainic belts, including the sources of the Des Moines river in Murray county, and the waters of Heron lake and its tributaries, went southward by the Little Sioux to the Missouri river, instead of going southeast, as now, by the Des Moines to the Mississippi. Thence northwest to the British Possessions, there was an unobstructed descending slope southward from the margin of the ice-fields; but a lake filled the valley of the South Saskatchewan, west of the Eyebrow Hill range and the Lumpy Hill of the Woods,* because in the direction of descent of this valley the ice-sheet was a barrier. The outflow of this lake where the ice-sheet terminated at the Eyebrow Hill range and the inner morainic belt of the Coteaus, was doubtless southward to the Missouri.

Again a more genial climate prevails, and when it is next interrupted by a cold epoch and the formation of another conspicuous series of drift-hills, the outlines of the ice-sheet are greatly changed. From southeast Dakota its border has receded to the north 400 miles, and lies beyond our national boundary at the Blue Hillis of the Souris. The region through which the Assiniboine flows, and the lower part of that crossed by its tributary, the Qu'Appelle, were still deeply covered by the ice which probably terminated westward near the Last Mountain and Touchwood hills, the Birch hills and the junction of the North and South Saskatchewan. From central Iowa the ice-front had also retreated 400 miles to the Mesabi range in northern Minnesota. Three-quarters of this distance was the vast glacial tongue or lobe which stretched from the Leaf hills to the vicinity of Des Moines, bounded by a land surface on the west to the head of the Big Sioux river, and on the

*Prof. H. Y. Hind's *Report of the Assiniboine and Sascatchewan Exploring Expedition*, p. 118.

east to the Leaf hills. During the disappearance of these vast areas of ice, the rivers which flowed from them were swollen to floods like the largest which, in exceptional years, accompany the sudden melting of the accumulated snows of winter. These last only a few days, but at the departure of the ice-sheet it is evident that such floods were prolonged through the entire summers of a long period of years. The abundant deposits of drift, both stratified and unstratified, that took place during the final melting of the ice, has been brought into due prominence by Prof. James D. Dana, who denominates this the champlain period. Much of the drift which had been contained in the glacial sheet was now dropped without being transported or assorted by water, and forms the upper part of the till. The remainder of this drift was removed by the streams that descended from the surface of the melting ice-fields, and its coarser portions were partly deposited in the channels of these glacial rivers, walled upon each side by ice, which afterward melted, leaving the ridges and mounds of interbedded gravel and sand called kames. These are generally inconspicuous in Minnesota, and from no long series such as have been described in the eastern States. The finer gravel and sand were mostly borne beyond the ice-margin, and were soon deposited, often with a more or less undulating surface, sometimes forming swells or low hills, but more generally in nearly flat plains of considerable extent, sloping a few feet per mile in the direction of the currents of the descending floods by which they were carried. Such beds of modified drift cover considerable portions of the basin of the upper Mississippi, from Minneapolis and Anoka county north to the Northern Pacific railroad, and to the lakes through which this river flows near its source. Along this distance the present channel has been excavated from 30 to 75 feet deep below the flood-plain which was overspread during every summer by the waters supplied by glacial melting in this epoch. The finest silt and clay were carried farthest, being partly deposited in spaces of nearly still water along this upper valley, but also adding largely to the loess along the whole extent of the river below.

Lakes were formed at many places by this great recession of the ice-sheet, where they have long since disappeared, either by cutting their outlets so deep that they were emptied, or by the removal of the ice-sheet which during its retreat northward formed the barrier by which they were enclosed. The most notable of the first class appears to have occupied the valley of the James river at Jamestown, until its overflows cut the deeply excavated channel

through which this river flows in southeastern Lamure and Brown counties. During the time of this erosion the volume of water flowing here was greatly augmented by glacial melting, and cut a deeper channel than the present diminished river has maintained, the silt since brought down by tributary streams having formed dams by which the river is changed to a series of long shallow lakes in these counties. A lake of the second class, held by the barrier of ice, covered the greater part of the basin of the Blue Earth river in Southern Minnesota, gradually extending north from the watershed at the south side of this basin, until the melting of the ice-sheet on the area crossed by the Minnesota river below Mankato allowed drainage to take its present course. The extent of this lake is indicated by the very smooth and flat surface of the till, which is imperfectly stratified in many places, on the greater part of Faribault, Blue Earth, and southwestern Waseca counties. Its outlet is found in Kossuth county, Iowa, at the head of the most southern branch of the Blue Earth river, where Union slough occupies a continuous channel from the headwaters of the Blue Earth to Buffalo creek and the East Fork of the Des Moines. It is stated that at time of high water an uninterrupted canoe voyage has been made by this route from Algona on the East Des Moines river north to Blue Earth City. This glacial channel is about eight miles long, extending in a southerly course; and its width is from one-eighth to one-fourth mile, with enclosing bluffs which rise steeply 20 to 30 feet to the general surface of moderately undulating till on each side. Its bottom along the Union slough, where its descent was southward, is now mainly occupied by a marsh, because of the partial filling up of its continuation since the ice age.

During the epoch in which the ice-sheet was accumulating the terminal moraine of the Mesabi hills and the Blue Hills of the Souris river, the lake in the South Saskatchewan valley remianed, held by the ice-barrier on the north; but it found a lower outlet than before at the divide between the River that Turns and the Qu'Appelle, 12 miles southeast from the elbow of the South Saskatchewan. A little farther east this outlet cut through the Eyebrow hill ridge, but its waters could not follow the present entire course of the Qu'Appelle, because the region of its lower portion and of the Assiniboine river were still covered by the ice-sheet. By this barrier the outflow from the Saskatchewan lake was turned south into the Souris or Mouse river, probably by the Souris Fork, tributary to the Qu'Appelle about 75 miles east, southeast from

the head of this river and near the junction of its North Fork from Long lake. The Souris river was also turned by the ice-sheet in a different course from that which it now takes. At the time of melting and retreat of the ice from the Coteaus, a lake covered the smooth, low area through which the loop of this river flows west of the medial moraine of Turtle Mountain. This at first probably found an outlet east by the Big Coule and Sheyenne river; but when the ice-border retired to its terminal line at the Blue hills, it appears that this lake was emptied by the Souris river, which took its course as now north of Turtle Mountain. It could not continue, however, to its present mouth, but was turned, probably flowing through a lake, at the very front of the ice-sheet, and sent its waters, including those of the Saskatchewan lake, by the avenue of the Back Fat creek and lakes, to the Pembina river.* A feature which marks nearly every stream that was thus the outlet of floods supplied by glacial melting, after they had been freed from the greater part of their sediment by flowing through a lake, is that the channel then excavated has been since partially filled by the silt of its tributaries, holding back the waters of the present rivers, in long, narrow and usually shallow lakes. The Back Fat lakes, and Rock and Swan lakes on the Pembina river, illustrate this; so, too, Lake Traverse, Big Stone lake and Lac qui Parle, in the valley which was the outlet of Lake Agassiz; and, still more notably, the lakes of the Qu'Appelle river.

The description, map, and section of the Qu'Appelle or Calling river and its bluffs, given in Professor Hind's valuable report, show that this valley is quite uniformly about one mile wide, and is from 110 to 350 feet below the general level of the region through which it lies, this height being reached by steep bluffs on each side. Its length, from the elbow of the South Saskatchewan to its junction with the Assiniboine is 268 miles, the general course being a little to the south of east. Of this extent the west end of the valley for 12 miles is occupied by the River that Turns, and the remainder by the Qu'Appelle, the summit or height of land in this channel at the divide between these rivers being 85 feet above the South Saskatchewan, and approximately 285 feet above the junction of the Qu'Appelle and Assiniboine rivers. The following table brings into view the remarkable topographic features of this valley, which is closely like that of the Minnesota river and Lake Traverse. Its alluvial bottomland appears to be from one-half mile to one mile wide, and through it the river flows in a winding

* Hind's *Report*, pp. 118 and 168.

course, here and there passing through long lakes. The enclosing bluffs are composed mainly of glacial till, with only a few exposures of the underlying Cretaceous rocks in this distance.

Section along the valley of the Qu'Appelle River.

LOCALITY.	Distances in miles fr'm mouth of Qu'Appelle river.	Approximate heights in feet above the sea.	Maximum depth of lakes in feet.	Aproximate height of bluffs in feet.
Mouth of Qu'Appelle river...............	....	1282	....	240
Round lake..............................	41—46	1343	30	310
Crooked lake............................	57—62	1357	36	300-320 (p59)
First Fishing lake......................	108—114	1422	66	300-350(p144)
Second Fishing lake.....................	115—118	1423	48	275
Third Fishing lake......................	119—124	1425	57	270
Fourth Fishing lake.....................	124—133	1426	54	270
Lake....................................	184—185	1504	about 15	185
Buffalo Pound Hill lake.................	194—210	1512	about 20	180
Sand Hill lake..........................	240—244	1552	about 20	115—150
Height of land..........................	256	1567	....	110—140
Ponds on the River that Turns..........	260—261	1549	about 10	110
Elbow of the South Saskatchewan river	268	1482	....	140

The east part of this valley and the Assiniboine valley which it joins were excavated after the ice-front had receded from its terminal moraine at the Mesabi and Blue hills, but apparently before its barrier was removed from the northeast end of the glacial lake in the Saskatchewan valley. The outflow of this lake, fed by the melting ice-fields of an immense area, reaching west to the glaciers of the Rocky Mountains, now took its course east by this singular, trough-like channel or valley, occupied to-day by the River that Turns and the Qu'Appelle, entering the Assiniboine at Fort Ellice, and reaching the border of Lake Agassiz near the mouth of the Souris river. The delta which this stream brought into Lake Agassiz forms a large area of sand hills and dunes, which extends 50 miles along the north side of the Assiniboine river next below the mouth of the Souris. During this time the ice-border lingered upon the highlands of the Riding or Dauphin Mountain, Duck Mountain, Porcupine hill and Pas Mountain at the west side of Manitoba, Dauphin and Winnipegosis lakes.

Step by step we have now followed the departing ice-sheet in its retreat from the terminal moraine of the Leaf hills and the Coteau des Prairies. For a time it had paused at the lines of the Mesabi and Blue hills; but when this delta was accumulated, it had again receded probably beyond the limits of Minnesota. Lake Agassiz,

held by this glacial barrier, had gradually extended from the height of land in Traverse county at the west side of this state, covering the flat valley of the Red River of the North, and reaching east at the north side of the state, beyond this basin, over a considerable part of that of the Lake of the Woods and Rainy Lake river. With the farther recession of the ice, the west shore of this glacial lake was extended along the great terrace which had been eroded, probably before the ice age, in the Cretaceous strata, forming Pembina, Riding and Duck mountains, Porcupine Hill and Pas Mountain. These consist of drift at their summits, and apparently to a great depth, and they form, with the Lake of the Woods and Vermilion lake, a dividing line between a region on the southwest, which is distinguished by very thick drift deposits, averaging from 100 to 200 feet in thickness, with rare exposures of the older rocks, and a region on the northeast, which has a comparatively thin sheet of drift, with abundant outcrops of the bed-rocks. At length the ice-sheet was melted between Lake Winnipeg and Hudson Bay, causing Lake Agassiz to be drained in that direction. At first, however, this took place by a pass about 90 feet higher than the present outlet of this basin by Nelson river, as shown by the well marked beach ridges at this height in the valley of the Red River and near Lakes Winnipeg and Manitoba.*

ELEVATIONS.

The following series of elevations have been determined by railroad surveys within the district specially explored and described in this report. Unless otherwise indicated, they refer to the track or grade at the depots, summits and depressions of the railroads; and all are stated in feet above the level of the sea at mean tide. They are given as they were received or copied from the records and profiles of these roads, and a comparison of their points of intersection, and of the determinations of the height of rivers, shows that they are all quite near the truth. The limits of error are apparently less than ten feet for all, excepting the line west from Salem in southeastern Dakota, which is a preliminary survey, making the James river some twenty feet higher than the two other elevations of this river at points farther north require.

Respecting the heights of the terminal and medial moraines, which close this list, it should be borne in mind that these depos-

*H. Y. Hind's *Report of the Assinniboine and Saskatchewan Exploring Expedition*, pp 39 and 40.

its vary in their elevation with the changes in the general altitude of the country which they cross. In most cases, their height is stated for a considerable area, as one or more counties; and their least and greatest elevations usually refer to different portions from twenty to fifty miles apart, between which there is commonly a gradual change in height, the topography of this region, excepting its moraines, being remarkably uniform and smooth.

Hastings & Dakota Division, Chicago. Milwaukee & St. Paul Railway.

Copied from profiles in the office of GEORGE H. WHITE, Engineer, Minneapolis.

	Distance in miles from Hastings.	Height in ft. above the Sea.
Low water in Mississippi River at Hastings..........	....	670.5
Hastings Junction with River Division..............	....	707.5
Glencoe..	74.	1006.5
Sumter...	79.9	1035 ....
Brownton...	84.4	1024 ....
Stewart..	94.1	1064 ....
Hector...	102.4	1081 ....
Bird Island......................................	111.6	1089 ....
Olivia...	116.0	1082 ....
Renville...	127.2	1064 ....
Sacred Heart.....................................	134.1	1061 ....
Hawk Creek, water................................	139.3	963 ....
Hawk Creek, bridge...............................	139.3	1017 ....
Minnesota Falls..................................	141.2	1041 ....
Granite Falls....................................	143.3	941 ....
Montivideo.......................................	156.6	927 ....
Chippewa River, water............................	156.8	913 ....
Watson...	162.9	1029 ....
Depression, grade................................	167.0	937 ....
Milan..	171.7	995 ....
Summit, grade....................................	177.1	1035 ....
Appleton...	179.8	1007 ....
Pomme de Terre River, water......................	180.1	978 ....
Correll..	186.9	980 ....
Odessa...	194.3	963 ....
Ortonville.......................................	202.0	990 ....
Big Stone Lake, water............................	.....	962.5
Lake Traverse, water.............................	.....	970 ....
Milbank Junction.................................	214.0	1149 ....
Foot of Coteau des Prairies......................	222.0	1294 ....
Summit of Coteau des Prairies....................	236–236.5	1993–2003

Winona & St. Peter Division, Chicago & Northwestern Railway.

From JOHN E. BLUNT, Engineer, Winona.

a. MAIN LINE.

	Distance in miles from Winona.	Height in feet above the Sea.
Low water in Mississippi River at Winona...........	.....	639.9
Top of rail on draw bridge.........................	.....	670.5
Winona..	0.	649 ....

	Distances in miles from Winona.	Height in above the sea.
Minnesota City	5.9	676 ....
Stockton	11.31	753 ....
Lewiston	18.30	1211 ....
Utica	22.74	1170 ....
St. Charles	28.35	1139 ....
Dover	32.19	1138 ....
Eyota	36.87	1237 ....
Chatfield Junction	37.73	1275 ....
Plainview Junction	37.93	1275 ....
Chester	42.74	1122 ....
Rochester	49.26	991 ....
R. & N. M. R'y Junction	50.64	999 ....
Olmsted	54.22	1054 ....
Byron	58.71	1250 ....
Kasson	63.87	1252 ....
Dodge Center	69.22	1288 ....
Claremont	76.36	1280 ....
Havana	83.90	1246 ....
Owatonna	88.17	1144 ....
Meriden	96.35	1149 ....
Waseca	102.63	1153 ....
Janesville	112.91	1063 ....
Eagle Lake	122.56	1012 ....
Mankato Junction	127.99	906 ....
Mankato	131.00	781 ....
Kasota	133.80	804 ....
Minnesota River bridge	135.00	791 ....
Minnesota River, low and high water	135.00	733–745
Saint Peter	136.19	812 ....
Oshawa	146.29	982 ....
Nicollet	150.88	980 ....
Courtland	158.56	936 ....
Minnesota River bridge	162.50	821 ....
Minnesota River, high water	162.50	807 ....
New Ulm	165.31	837 ....
Siding	169.00	994 ....
Sleepy Eye	179.72	1034 ....
Redwood Falls	.....	1028 ....
Springfield	193.18	1025 ....
Sanborn	201.56	1089 ....
Lamberton	208.77	1144 ....
Walnut Grove	218.98	1223 ....
Tracy	226.55	1403 ....
Amiret	233.65	1283 ....
Marshall	243.85	1174 ....
Grand View	250.75	1173 ....
Minneota	256.52	1179 ....
Canby	274.03	1243 ....
Gary	284.62	1484 ....
Altamont	297.38	1834 ....
Goodwin	305.90	1996 ....
Kranzburg	309.53	1982 ....
Watertown	319.10	1733 ....
Sioux River, water	320.00	1709 ....
Lake Kampeska, water	322.00	1714 ....

b. BRANCH TO CHATFIELD.

Chatfield Junction	37.73	1275 ....

	Distances in miles from Winona.	Height in feet above the Sea.
Summit, grade	40.75	1295 ....
Chatfield	48.87	976 ....

c. BRANCH TO PLAINVIEW.

Plainview Junction	37.93	1275 ....
Doty	40.00	1310 ....
Viola	43.00	1129 ....
Whitewater Creek	47.00	1055 ....
Elgin	48.17	1069 ....
Plainview	52.93	1167 ....

d. BRANCH TO ZUMBROTA.

R. & N. M. Junction	50.64	999 ....
Douglass	58.35	1091 ....
Zumbro River	60.25	966 ....
Zumbro bridge	60.25	986 ....
Oronoco	61.72	1041 ....
Zumbro River	65.20	984 ....
Zumbro bridge	65.20	993 ....
Pine Island	65.86	998 ....
Lena	70.66	1073 ....
Forest Mills	73.14	1023 ....
Zumbrota	74.56	971 ....

e. DAKOTA CENTRAL RAILWAY.

Tracy	226.55	1403 ....
Balaton	239.55	1528 ....
Redwood River	246.60	1592 ....
Redwood bridge	246.60	1631 ....
Tyler	253.70	1750 ....
Lake Benton	261.50	1759 ....
Verdi	267.6	1771 ....
Elkton	274.3	1851 ....
Aurora	285.1	1630 ....
Summit, grade	288.9	1683 ....
Brookings	290.8	1636 ....
Sioux River	296.4	1596 ....
Sioux bridge	296.4	1607 ....
Volga	297.4	1636 ....
Nordland	308.3	1846 ....
Lake Preston	317.3	1696 ....
De Smet	329.6	1726 ....
Summit, grade	331.4	1767 ....
Fairview	338.3	1542 ....
Iroquis	344.8	1401 ....
Cavour	354.0	1311 ....
James River	361.8	1228 ....
James bridge	361.8	1270 ....
Huron	362.9	1285 ....
Huron Junction	366.9	1312 ....
Pierre	482.0	1438 ....
Missouri river	482.0	1424 ....

Southern Minnesota Division; Chicago, Milwaukee & St. Paul Railway.

From GEORGE B. WOODWORTH, Assistant Engineer, La Crosse.

a. MAIN LINE.

	Distances in miles from La Crosse.	Height in feet above the Sea.
Low water in Mississippi River at La Crosse	.....	626.3
Junction with River Division, west of bridge	0	653 ....
La Creseent	0.7	647 ....
C. C. D. & M. Junction	3.0	641 ....
Root River bridge	4.2	648 ....
Hokah	6.2	649 ....
Root River bridge	11.0	663 ....
Mound Prairie	12.2	660 ....
Root River bridge	14.0	669 ....
Houston	18.7	679 ....
Root River bridge	22.3	703 ....
Money Creek	23.2	699 ....
Rushford	29.9	722 ....
Peterson	34.5	756 ....
Whalan	43.4	786 ....
Root River bridge	46.0	801 ....
Root River bridge	47.5	824 ....
Lanesboro	48.0	841 ....
Root River bridge	51.7	873 ....
Isinour's	53.6	899 ....
Fountain	59.3	1302 ....
Depression, grade	60.6	1259 ....
Summit, grade	64.7	1330 ....
Wykoff	66.5	1310 ....
Summit, grade	68.5	1367 ....
Spring Valley	73.6	1266 ....
Summit, grade	80.1	1358 ....
Grand Meadow	83.0	1338 ....
Depression, grade	85.2	1317 ....
Dexter	89.8	1412 ....
Brownsdale	98.0	1271 ....
Cedar river, water	102.9	1192 ....
Ramsey, crossing Minnesota Div. of C. M. & St. P. Ry.	103.1	1214 ....
Depression, grade	107.7	1197 ....
Oakland	109.9	1265 ....
Summit, grade	113.8	1270 ....
Depression, grade	117.6	1241 ....
Hayward	118.0	1248 ....
Summit, grade	121.5	1263 ....
Depression, grade	124.2	1206 ....
Albert Lea	124.6	1221 ....
B., C., R. & N. crossing	124.7	1220 ....
Summit, grade	128.9	1323 ....
Armstrong	129.8	1270 ....
Summit, grade	133.5	1317 ....
Alden	135.2	1261 ....
Dood's Switch	139.7	1189 ....
Wells	144.4	1153 ....
Junction of Mankato branch	144.7	1145 ....
Easton	153.3	1046 ....
Summit, grade	157.1	1077 ....
Delevan	159.2	1067 ....
Depression, grade	159.5	1047 ....
Crossing branch of St. P. & S. C. R. R. Co.	166.1	1096 ....
Winnebago City	166.3	1096 ....

	Distances in miles from La Crosse.	Height in feet above the sea.
Blue Earth river, water	168.4	1014 ....
Fairmont	183	1176 ....
Sherburne	197.5	1273 ....
Top of bluff at junction of branch to Jackson depot	209.1	1446 ....
Des Moines river, water	211.8	1288 ....
Des Moines river bridge	211.8	1353 ....
Summit, grade	216.6	1517 ....
Lakefield	220.6	1463 ....
Okabena	229.1	1410 ....
Crossing St. P. & S. C. R. R	232.2	1414 ....
De Forest	239.5	1446 ....
Fulda	246.1	1508 ....
Iona	255.6	1608 ....
Summit, grade	259.4	1705 ....
Entering Chanarambie valley, grade	264.0	1634 ....
Chanarambie creek, water at last crossing	274.5	1521 ....
Edgerton	276.0	1550 ....
Rock river	279.0	1552 ....
Hatfield	283.0	1662 ....
Highest point on road	285.5	1744 ....
Pipestone city	289.0	1693 ....
Pipestone creek, water	293.0	1577 ....
Airlie	295.5	1629 ....
Flandreau	303.6	1550 ....
Big Sioux river, water	306.1	1495 ....
Egan	308.0	1510 ....
Sioux Falls Junction	309.9	1496 ....
Summit, grade	315.0	1695 ....
Summit, grade	328.5	1705 ....
Summit, grade	330.8	1691 ....
Madison Lake, 2 mi. S. of last	.....	1576 ....
New Madison	332.6	1646 ....
Herman	335.0	1654 ....
Lake Herman	.....	1646 ....
Summit of hills, approximately	342.0	1825 ....
Top of bluff	342.2	1732 ....
East Vermilion River, water	344.1	1607 ....
Top of bluff	345.5	1694 ....
Top of bluff	352.3	1583 ....
West Vermilion River, water	354.0	1518 ....
Top of bluff	360.6	1404 ....
Rock Creek, water	360.9	1367 ....
Top of bank	361.5	1392 ....
Little Jim Flats	370.6	1293 ....
Top of bluff	381.3	1266 ....
James River, water	383.0	1195 ...
Prairie west of James River	388.0	1260 ....

b. BRANCH TO MANKATO.

Junction near Wells	144.7	1145 ....
Minnesota Lake	153.0	1038 ....
Mapleton	161.4	1031 ....
Maple River, water	168.5	935 ....
Good Thunder	169.3	974 ....
Rapidan	175.6	979 ....
Le Sueur River, water	177.9	772 ....
Le Sueur River, bridge	177.9	825 ....
Crossing St. P. & S. C. R. R	181.3	795 ....

	Distances in miles from La Crosse.	Height in feet above the sea.
Mankato	182.5	770 ....
Minnesota River, water	.....	748 ....

c. BRANCH TO SIOUX FALLS.

Sioux Falls Junction	309.9	1496 ....
Big Sioux River, water, second crossing	310.7	1479 ....
Big Sioux River, water, third crossing	315.8	1461 ....
Dell Rapids	322.7	1467 ....
Big Sioux River, water, fourth crossing	323.0	1452 ....
Top of hill above Sioux Falls	340.5	1404 ....
Sioux Falls	341.6	1375 ....
Big Sioux River, water	341.7	1355 ....

Iowa & Dakota Division, Chicago, Milwaukee & St. Paul Railway.

Copied from profiles in the office of George H. White, Engineer, Minneapolis.

	Distances in miles from N. McGregor.	Height in feet above the Sea.
Low and high water in Mississippi River at McGregor.	.....	615.9-634
North McGregor	0	633 ....
Monona	14.07	1221 ....
Luana	17.90	1132 ....
Postville	24.49	1207 ....
Castalia	30.64	1257 ....
Ossian	35.70	1281 ....
Calmar	42.04	1269 ....
Summit, grade	42.90	1300 ....
Conover	45.26	1247 ....
Cresco	60.80	1312 ....
Lime Springs	71.78	1258 ....
Chester	76.41	1244 ....
Le Roy	84.25	1298 ....
Decorah	53.90	900 ....
Turkey River, water	47.39	1002 ....
Fort Atkinson	47.73	1023 ....
New Hampton	69.06	1166 ....
Middle Wapsipinicon River, water	72.84	1061 ....
Chickasaw	76.66	1148 ....
Crossing C. V. R. R	88.15	1020 ....
Charles City	88.53	1012 ....
Cedar River, water	89.65	995 ....
Shell Rock River, water	106.45	1033 ....
Shell Rock River, bridge	106.45	1053 ....
Lime Creek, water	112.55	1052 ....
Lime Creek, bridge	112.55	1071 ....
Mason City, depot and crossing, R. R	115.90	1130 ....
Clear Lake, depot	125.67	1237 ....
Summit, grade	131.56	1272 ....
Garner	135.20	1227 ....
East Fork of Iowa River, water	137.91	1200 ....
Crossing, M. & St. L. Ry	146.19	1210 ....
Britt	147.19	1232 ....
Summit, grade	155.09	1269 ....
Wesley	156.87	1254 ....
Near Algona (0 of line west)	168.19	1191 ....

Iowa Division, Illinois Central Railroad.

From GANNETT'S List of Elevations, fourth edition.

	Heights in feet above the Sea.
Fa~~irfield~~rley Junction	1131
Manchester	933
Winthrop	1080
Independence	924
Waterloo, Cedar River	864
Ackley	1141
Summit between Cedar and Iowa rivers	1221
Iowa Falls, Iowa River	1071
Alden	1165
Summit between Iowa River and its South Fork	1204
South Fork of Iowa River	1159
Blainsburg	1230
Summit between Iowa and Boone Rivers	1260
Webster City	1039
Duncomb	1111
Summit between Boone and Des Moines rivers	1171
Fort Dodge	1001
Summit between Des Moines and Raccoon rivers	1330
Raccoon River	1279
Summit between Raccoon and Little Sioux rivers	1519
Cherokee, Little Sioux River	1176
Summit between Little Sioux and Floyd rivers	1488
Floyd River	1166

Chicago & Northwestern Railway, in Iowa.

From GANNETT'S List of Elevations.

Marshalltown	905
State Center	1093
Nevada	1024
Ames	943
Boone	1162
Moingona, bridge over Des Moines River	914
Moingona, low water of Des Moines River	877
Ogden	1116
Beaver	1048
Grand Junction	1062
Jefferson	1078
Raccoon River	1004
Glidden	1238
Carroll	1247
Arcadia, on divide between the Mississippi and Missouri rivers	1446
Divide, natural ground	1468
Denison	1199
Council Bluffs	1007

Minneapolis & St. Louis Railway.

From ROBERT ANGST, Assistant Engineer, Minneapolis.

	Distance in miles from Minneapolis.	Height in feet above the Sea.
Minneapolis	0.	825 ....
Hopkins	8.7	919 ....

	Distances in miles from Minneapolis.	Height in feet above the sea.
Eden Prairie	15.2	882
Summit, grade	18.7	875
Chaska	22.7	725
Carver	24.7	719
Low water in Minnesota River	24.7	689
Merriam Junction, St. P. & S. City R. R.	27.2	753
Jordan	32.3	753
Helena	36.3	886
New Prague	42.6	978
Montgomery	50.0	1063
Mulford's Siding	54.6	1060
Kilkenny	58.6	1056
Waterville	65.4	1008
Iosco	69.7	1146
Waseca	76.2	1151
New Richland	88.7	1178
Hartland	94.9	1247
Manchester	100.9	1258
Albert Lea	108.0	1224
Twin Lakes	115.0	1255
Norman	121.4	1279
Lake Mills	127.2	1264
Benson's Grove	136.0	1216
Forest City	141.7	1220
Crossing C., M. & St. P. R'y	155.5	1207
Britt	156.3	1230
Corinth	167.0	1180
Livermore	181.6	1135
Humboldt	192.0	1089
Fort Dodge, upper depot	210.0	1120

St. Paul & Sioux City Division, Chicago, St. P., Minneapolis & Omaha R'y.

Copied from profiles in the office of T. P. Gere, Superintendent, and H. S. Treherne, Assistant Engineer, St. Paul.

a. MAIN LINE.

	Distance in miles from St. Paul.	Height in feet above the Sea.
Saint Paul	0.	698.4
Mendota	5.5	718
Nicols	9.9	706
Hamilton	17.7	714
Eagle Creek, bridge	19.7	708
Bloomington	21.2	738
Shakopee	26.8	741
Summit, grade	32.6	764
Brentwood	38.0	749
Summit, grade	40.0	768
Belle Plaine	45.6	725
High water in Minnesota River here	45.6	718
Blakeley	49.9	728
East Henderson	56.8	734
Le Sueur	61.5	753
High water in Minnesota River here	61.5	735
Ottawa	67.6	790
East Saint Peter	73.4	748
Kasota Junction	75.9	800

	Distances in miles from St. Paul.	Height in feet above the sea.
Summit, grade	77.8	837 ....
Mankato	84.0	791 ....
Blue Earth River, low and high water	86.2	756–774
Blue Earth River, bridge	86.2	795 ....
South Bend	87.6	808 ....
Minneopa bridge, 68 feet above water	89.2	863 ....
Minneopa	89.4	871 ....
Summit Grade	95.6	992 ....
Lake Crystal	97.3	994 ....
Summit, grade	102.2	1009 ....
Iceland	104.1	998 ....
Medalia	109.0	1021 ....
Watonwan River, water	110.5	979 ....
Lincoln	116.4	1042 ....
Saint James	121.6	1073 ....
Butterfield	130.1	1184 ....
Mountain Lake	137.0	1300 ....
Bingham Lake	143.2	1420 ....
Summit, grade	144.1	1437 ....
Windom	147.8	1353 ....
Des Moines River, water	148.1	1331 ....
Bluff Siding	149.7	1425 ....
Wilder	154.0	1448 ....
Heron Lake, water	159.0–159.5	1403 ....
Heron Lake, depot	160.3	1417 ....
Hersey (Brewster)	170.0	1485 ....
Elk Creek, water	171.5	1473 ....
Summit, grade	178.2	1588 ....
Worthington	178.4	1582 ....
East Okabena Lake, water	178.5	1569 ....
Junction of Sioux Falls Branch	181.8	1633 ....
Summit, grade	182.3	1654 ....
Summit, grade	184.6	1656 ....
Bigelow	187.8	1631 ....
State line	188.3	1643 ....
Summit, grade, 1647; surface	188.9	1653 ....
Sibley	195.9	1509 ....
St. Gilman	202.4	1442 ....
Sheldon	212.1	1406 ....
Hospers	220.1	1338 ....
East Orange	228.5	1302 ....
Seney	239.7	1221 ....
Le Mars	244.2	1221 ....
Floyd River, here	244.2	1197 ....
Sioux City	270.0	1122 ....

b. WOODSTOCK BRANCH.

Heron Lake, junction	160.3	1417 ....
Dundee	168.4	1443 ....
Avoca	180.1	1533 ....
Two summits, grade	201.1–201.9	1850–1849
Murray and Pipestone county line, grade	202.5	1839 ....
Woodstock	204.3	1822 ....
Rock River, water	208.3	1645 ....
Summit	211.5	1785 ....
Pipestone City	215.4	1715 ....
Big Sioux River at Flandreau	230.8	1501 ....
Prairie, 4 miles further west	235.0	1662 ....

c. SIOUX FALLS BRANCH.

	Distances in miles from St. Paul.	Height in feet above the sea.
Junction	181.8	1633 ....
Summit, grade	184.5	1691 ....
Little Rock River, water	187.4	1629 ....
Little Rock River, bridge	187.4	1649 ....
Rushmore	190.1	1665 ....
Adrian	196.9	1538 ....
Kanaranza Creek, water	198.0	1499 ....
Kanaranza Creek, bridge	198.0	1511 ....
Summit, grade	199.5	1569 ....
Drake	203.7	1516 ....
Elk Slough, grade	206.2	1469 ....
Summit, grade	207.1	1515 ....
Rock River, water	210.3	1423 ....
Luverne	211.1	1451 ....
Summit, grade	216.1	1543 ...
Beaver Creek, depot	219.3	1443 ....
Beaver Creek, water	219.8	1385 ....
State line	224.4	1383 ....
Valley Springs	225.2	1392 ....
Big Sioux River, low and high water	232.4	1281–1302
Big Sioux River, bridge	232.4	1307 ....
Terrace, south of river	234.4	1363 ....
Sioux Falls	240.2	1394 ....
Big Sioux River, low and high water	240.4	1331–13[illegible]
Summit, grade	241.6	1471 ....
Big Sioux River, water	243.4	1403 ....
Skunk Creek, water, Sec. 31, T. 102, R. 50	250.0	1449 ....
Skunk Creek, bridge	250.0	1465 ....
Hartford Siding, Sec. 22, T. 102, R. 51	254.4	1561 ....
Summit, grade, Sec. 9, T. 102, R. 52	261.2	1692 ....
East Vermilion River, water, Sec. 27, T. 103, R. 53	268.0	1455 ....
East Vermilion River, bridge	268.0	1469 ....
Montrose Siding, close west of last	268.3	1471 ....
West branch of E. Vermilian River, water, at S. W. corner of Sec. 15, T. 103, R. 53	269.5	1468 ....
Bridge here	269.5	1480 ....
Summit, grade	275.9	1586 ....
Salem, Sec. 13, T. 103, R. 55	279.5	1517 ....
West Vermilion River, watar, Sec. 15, T. 103, R. 55	281.0	1457 ....
Wolf Creek, water, Sec. 20, T. 104, R. 56	290.6	1370 ....
Fawn Lake, water, T. 105, R. 58	303.5	1320 ....
Stony Creek, water, Sec. 25, T. 106, R. 60	313.0	1253 ....
James River, water, Sec. 12, T, 106, R. 61	320.2	1212 ....
Prairie, 5 miles west of last	325.0	1276 ....

d. FROM LUVERNE TO DOON.

Luverne	211.1	1451 ....
Ash Creek depot	218.7	1396 ....
State line	221.6	1374 ....
Rock Rapids	226.5	1344 ....
Rock River, low and high water	231.0	1296–1311
Doon	238.9	1282 ....
Rock River at S. line of Lyon county, Iowa, low and high water	240.2	1248–1266

Elevation of the Terminal and Medial Moraines in Minnesota, Iowa, and Dakota.

a. FROM BECKER SOUTH TO FREEBORN COUNTY.

	Height in feet above the Sea.
At White Earth Agency	1600 ....
East of Detroit	1450–1500
East of Lake Lida	1425 ....
East of Fergus Falls	1300 ....
Leaf hills	1400–1750
At Glenwood	1250–1300
Blue Mounds	1250–1300
In Meeker and Wright counties	1225–1000
In Hennepin and Scott counties	950–1050
In Le Sueur and Rice counties	1050–1150
In Waseca county	1100–1200
In Steele county	1150–1350
In Freeborn county, eastern Moraine	1275–1300
Western or inner Moraine in this county	1300–1375
Kiester hills, Faribault county	1300–1400
Medial Moraine, northwest to Delevan	1300–1100

b. IN IOWA.

In Worth and Winnebago counties	1250–1350
Pilot Mound, Hancock county, about	1425 ....
Medial Moraine, northwest to Fairmont, Minn	1325–1225
Medial Moraine, west to Lake George	1250–1300
In Wright and Franklin counties	1350–1200
In Hardin and Hamilton counties	1250–1150
Mineral ridge, in northern Boone county, about	1200 ....
In Guthrie and Carroll counties	1200–1325
In Sac and Buena Vista counties	1275–1500
In Palo Alto, Clay, Emmett and Dickinson counties	1300–1600
Spirit Lake, about 1400; hills west of do	1475–1525
In northeastern Osceola county	1550–1675

c. THE COTEAU DES PRAIRIES.

1. *The Eastern or Inner Moraine.*

In Jackson county	1450–1475
Blue Mounds, Cottonwood county	1450–1525
In Murray and Lyon counties	1500–1600
In Lincoln and Yellow Medicine counties, and onward in Dakota	1500–1650
Antelope Hills range	1250–1300

2. *The Western or Outer Moraine.*

In Nobles county	1650–1750
In Murray county	1750–1900
In northeastern Pipestone county	1850–1900
In southwestern Lincoln county	1900 1960
In Dakota, from the west line of Lincoln county to the head of the Coteau des Prairies	1900–2050

d. MEDIAL MORAINE.

	Height in feet above the sea.
Northward to Devil's Lake and Turtle Mountain, mostly	1400–1600
Devil's Lake (Nicollet)	1476 ....
Mini-wakan-chante, hill, south of do. (Nicollet)	1766 ....
Turtle Mountain (Dawson's map)	2150 ....
Turtle Mountain (U. S. By. Com. profile)	2000–2534

e. TERMINAL MORAINE FROM THE HEAD OF THE COTEAU DES PRAIRIES TO THE COTEAU DU MISSOURI.

In Codington, Hamlin, Brookings and Lake counties	1800–1900

f. THE COTEAU DU MISSOURI.

Through central Dakota	1800–2200
At the north line of the United States	2000–2200

X.

CHEMISTRY.

ANALYSIS BY PROF. DODGE.

MINNEAPOLIS, Dec. 14, 1880.

PROF. WINCHELL—

Dear Sir:—I hand you, at length, results of analysis of the substance * you left with me at the chemical laboratory about two months since—the lime-clay material stated to have character of a cement.

Hoping tnat the results I communicate may not come too late to be of any service, I remain,

Very truly yours,
JAMES A. DODGE.

Mineral powdered, dried at 100°c., digested with dil. Hcl.:—

Dissolved by Hcl	55.1p.
Residue	46.9
	100.0

Analysis of portion dissolved by Hcl.:—

CO_2	41.06p	21.8p.	of entire mineral.
SiO_2	0.98	0.52	" "
Al_2O_3	traces	.....	" "
Fe_2O_3	6.78	3.6	" "
CaO.	49.53	26.3	" "
MgO.	1.51	0.8	" "
K_2O	traces	.....	
Na_2O	traces	.....	
	99.86p	53.02p	

* This substance is a clay from the Red river valley, near Grand Forks, Dakota.

Analysis of portion undissolved by Hcl.: Boiled with solution of carb. of soda, gave only slight traces of Si. O_2. Fused with carb. soda-potass., gave:

Si O_2	61.69p	28.93p.	of entire mineral
Al_2 O_3	29.93	14.04	" "
Fe_2 O_3	5.99	1.91	" "
Ca O	traces	.....	" "
Mg O	0.98	0.46	" "
K_2 O	traces	.....	
Na_2 O	traces	.....	
	98.59p	46.24p	

XI.

ORNITHOLOGY.

(REPORT OF DR. P. L. HATCH.)

PROF. N. H. WINCHELL—

Sir:—The present year has made no signal additions to the number of species of birds found to belong in the State. Explorations have been made over considerable sections hitherto unnoticed, and more critically over those somewhat familiar to me in the past, which have been rewarded by much desirable information, but without any discoveries of new forms, except in finding some accidental stragglers from well-known habitats, as in the case of the cinnamon teal, *Querquedula cyanoptera (Viriell), Cassin,* found at Bigstone lake, on the western border of the State. It is highly probable that very little remains to be done in the work of identification. There can be no doubt that occasionally a species will yet be added from those known to visit the same latitudes in contiguous territories, or even from more remote localities. Several such have recently been added to the lists of such old states as Maine, Massachusetts and Ohio. Indeed several that are new to science have recently been collected and described by competent and reliable ornothologists, resident in those states, which multiplies the probabilities that such will be the case here, yet this does not affect the conclusion that the list for Minnesota is about full. Entertaining this view, while employing the utmost vigilance to let none escape my notice, I have devoted my attention principally to the local habits, relative numbers and migrations of those already identified. I desire in this way to make the history of the

birds of Minnesota, when completed, of the most value to the ends for which this subdivision of the State natural history survey was instituted. I find it no small undertaking to ascertain the average distribution of species on so wide a domain, considerable of which is remote and some of which is extremely difficult to explore after access has been attained.

I understand better than I did once, why so few competent naturalists have undertaken the life-histories of birds in the interest of agriculture. To follow a single species from the time of its arrival until its departure, and record its habits of migration, feeding through all the months, nesting, rearing and protecting its young, seems to be task enough for the spare hours of any one individual, but what of it when instead of one we have nearly three hundred. While, however, I am doing this with the assistance of all reliable aid which I can enlist, there is an increasing demand for a correct list north for the use of collectors and for scientific purposes in the other states and foreign countries, which I have now completed and herewith place in your hands for publication, if it shall meet your approval.

Yours very respectfully,

P. L. HATCH.

Minneapolis, October 21, 1880.

A LIST OF THE BIRDS OF MINNESOTA,

BY DR. P. L. HATCH, OF MINNEAPOLIS.

This list was in the hands of the printer long since, when a disastrous conflagration destroyed it, and it has been impossible to give its re-writing the measure of carefulness which the first manuscript received. If errors shall have crept in I believe they will be found to be unimportant. Although unfortunatety delayed by the circumstance mentioned, I have fulfilled my purpose and my promise to the many who have been calling on me for it so long and so complimentarily.

1. **Turdus migratorius**—ROBIN—common over the State.
2. **T. mustelinus**—WOOD THRUSH—common for the species.
3. **T. pallasii**—HERMIT THRUSH—proportionately represented.
4. **T. swainsoni**—SWAINSON'S THRUSH—common, and the variety Aliciæ said to have been obtained.
5. **T. fuscescens**—WILSON'S THRUSH—not as frequently seen, perhaps, as the last.
6. **Mimus carolinensis**—CATBIRD—exceedingly common.
7. **Harporhynchus rufus**—BROWNTHRESHR—very common.
8. **Sialia sialis**—BLUEBIRD—not less common than last.
9. **Sialia mexicana**—WESTERN BLUEBIRD—only one seen—Red River.
10. **Regulus calendulus**—RUBY-CROWNED KINGLET—common in migration associated with Satrapa.
11. **Regulus satrapa**—less frequently seen in migration.
12. **Polioptila coarulea**—BLUE-GRAY GNAT CATCHER—very rare.
13. **Lophophanes bicolor**—TUFTED TITMOUSE—exceedingly rare.
14. **Parus atricapillus**—BLACK-CAPPED TITMOUSE, or "Chickadee"—common and a permanent resident.
15. **Parus atricapillus, var. septentrionalis**—rare, but seen several times.
16. **Sitta carolinensis**—WHITE-BILLEDNUTHATCH—common resident.

17. **Sitta canadensis**—RED-BILLED NUTHATCH—less common resident.

18. **Certhia familiaris**—BROWN CREEPER—common.

19. **Thryotorus bewickii**—BEWICK'S WREN—common in summer.

20. **Troglodites aedon**—HOUSE WREN—common.

20½. **T. aedon, var. parkmani**—HOUSE WREN—common

21. **Anorthura troglodytes, var. Hyemalis**—WINTER WREN—also common.

22. **Telmatodytes palustris**—LONG-BILLLD MARSH WREN—common

23. **Cistothorus stellaris**—SHORT-BILLED MARSH WREN—also common.

24. **Eremophila alpestris**—SHORELARK—very common.

25. **Anthus ludovicianus**—TITLARK—not uncommon in migration and sometimes abundant.

26. **Neocorys spraguei**—MISSOURI SKYLARK—very rare.

27. **Mniotilta varia**—BLACK AND WHITE CREEPER—Rather a common warbler—breeds here.

28. **Parula americana**—BLUE YELLOW BACKED WARBLER—not common.

29. **Helminthophaga pinus**—BLUE-WINGED YELLOW WARBLER—about like the last species in frequency.

30. **H. chrysoptera**—BLUE GOLDEN WINGED WARBLER—not abundant. Breeds here however.

31. **H, Ruficapilla**—NASHVILLE WARBLER—common and breeds here in many observed localities.

32. **H. celata**—ORANGE-CROWNED WARBLEr—common, and breeds here also.

33. **H. peregrina**—Another warbler seen abundantly during migration—a few nests have been seen.

34. **Dendroeca aestiva**.-BLUE-EYED YELLOW WARBLER-the most common of the Warblers during summer, and breeds here in great abundance.

35. **D. virens**—BLACK-THROATED GREEN WARBLER—a much less numerous specie; breeds here.

36. **D. coerulescens**—BLACK-THROATED BLUE WARBLER—often seen in migration—I am not aware of any nests having been taken, but think it breeds in the State.

37. **D. coerulea**—COERULEAN WARBLER—Occasionally seen in spring—Little known of its local habits.

38. **D. coronata**—YELLOW-RUMPED WARBLER—The earliest and by far most numerous of all the warblers during migration, and breeds to some extent in the vicinity of Lake Superior.

39. **D. striata**—Black-Poll Warbler—Very common from the 10th to the 20th of May—Breeds here.

40. **D. castanea**—Bay-brested Warbler—Often observed in migration—Little more known of it.

41. **D. blackburniæ**—Blackburnian Warbler—Rather a common migrant and breeds here.

42. **D. pennsylvanica**—Chestnut-sided Warbler—Quite common—Nests have frequently been obtained.

43. **D. maculosa**—Black and Yellow Warbler—Not uncommon—I have seen no nests, but have no doubt as to its breeding here.

44. **D. tigrina**—Cape May Warbler—Very common in migration.

45. **D. palmarum**—Yellow Red-poll Warbler—Not very infrequent in a short period of its migration—No nests seen as yet.

46. **D. pinus**—Pine Creeping Warbler—Seen only in migration except in a single instance in Grants county by T. S. Roberts in the early part of June.

47. **Seiurus aurocapillus**—Golden-crowned Thrush—common during migration, and nests are occasionally observed.

48. **S. noveboracensis**—Water Thrush—not very common but also breeds here.

49. **Oporornis agilis**—Connecticut Warbler—rare.

50. **Geothlypis trichas**—Maryland Yellow-throat—very common—breeds here abundantly.

51. **G. philadelphia**—Mourning Warbler—seen rather infrequently—I think one nest has been obtained by Mr. T. S. Roberts. Mr. Trippe, quoted by Dr. Cones, found it very common and breeding here abundantty, but twenty-two years residence has afforded me less favorable results. I have not looked for it, however, in the localities he mentioned.

52. **Icteria viridis**—Yellow-breasted Chat—Very rare as yet—Only seen on the western borders of the State and in Dakota along the Missouri.

53. **Myiodioctes pusillus**—Green Black-capped Fly-catcher—Not very abundant but breeds here.

54. **M. canadensis**—About like the last species, and the nests are said to have been seen.

55. **Setophaga ruticilla**—Redstart—Common, and breeds here in well-observed localities.

56. **Pyranga rubra**—Scarlet Tanager—Every year becoming more common—Nests often taken.

57. **Hirundo Horreorum**—Barn Swallow—Abundant in some sections, but not universally so.

58. **Tachycineta bicolor**—White-bellied Swallow—Abundant.

59. **T. thalassina**—VIOLET-GREEN SWALLOW—Not so well represented as the last.

60. **Petrochelidon lunifrous**—EAVE SWALLOW—Common.

61. **Cotyle riparia**—BANK SWALLOW—Also very common.

62. **Stelgidopteryx serripennis**—ROUGH-WINGED SWALLOW—not common.

63. **Progne purpurea**—PURPLE MARTIN—abundant.

64. **Ampelis garrulus**—BOHEMIAN WAX-WING—This winter visitants numbers vary so much from year to year as to forbid any approximately definite description—sometimes common.

65. **A. cedrorum**—CEDAR BIRD—common, and breeds in various section.

66. **Vireo olivaceus**—RED-EYED VIREO—common.

67. **V. philadelphicus**—BROTHERLY-LOVE BIRD—quite a number have been identified, but I do not think it a common specie.

68. **V. gilvus**—WARBLING VIREO—delightfully common.

69. **V. flavifrons**—YELLOW-THROATED VIREO—not at all common, but breeds here.

70. **V, solitarius**—SOLITARY VIREO—common in migration. Breeds in northern sections of the State.

71. **V. noveboracensis**—WHITE-EYED VIREO—rare as far as yet observed—at least not common.

72. **V. bellii**—BELL'S VIREO—not a common specie.

73. **Collurio borealis**—GREAT NORTHERN SHRIKE—Is fairly common but far less so than the next species.

74. **C. excubitoroides**—WHITE-RUMPED SHRIKE—Which is exceedingly common.

75. **Hesperiphona vespertina**—EVENING GROSBEAK-Like the Chatterer or Bohemian wax wing. The representation of these winter visitors is exceedingly variable, yet never as great as in that species.

76. **Pinicola enucleator**—PINE GROSBEAK—Much the same as the Evening Grosbeak.

77. **Carpodacus purpureus**—PURPLE FINCH—Common occasionally in fall migration.

78. **Curvirostra americana**—RED CROSS-BILL—Not exactly common—Breeds in north part of the State.

79. **C. leucoptera**—WHITE-WINGED CROSS-BILL—Rather rare.

80. **Aegiothus linarius**—RED-POLL LINNET—Common in winter.

81. **Chrisomitris pinus**—PINE LINNET—Not rare.

82. **C. tristis**—American Goldfinch—very common and breeds extensively.

83. **Plectrophanes nivalis**—Snow Bunting—a very abundant species in winter.

84. **P. lapponicus**—Lapland Longspur—not as constant during the winter but very numerous in both migrations.

85. **P. ornatus**—Chestnut colored Bunting—common along the Red River, where it breeds.

86. **P. pictus**—Painted Lark Bunting—not much observed, but identified.

87. **Centronyx bairdii**—Baird's Sparrow–common along the Red River where it breeds.

88. **Passerculus savanna**—Savanna Sparrow—common, breeding here abundantly.

89. **Poocætes gramineus**—Bay-winged Bunting—common.

90. **Coturniculus passerinus**—Yellow Winged Sparrow—less common than the last.

91. **C. leconti**—Leconte's Sparrow—well identified.

92. **Melospiza lincolni**—Lincoln's Sparrow—about the same as Leconti—either or both are doubtless not infrequent in some localities.

93. **M. palustris**—Swamp Sparrow—Abundant.

94. **M. melodia**—Song Sparrow—Very common.

95. **Junco Tryemalis**—Snow Bird—Abundant—Breeds here.

96. **I. oregonus**—Oregon Snowbird—A few stragglers.

97. **Spizella monticola**—Tree Sparrow—Common.

98. **S. socialis**—Chipping Sparrow—Very common.

99. **S. pusilla**—Field Sparrow—Also common.

100. **S. pallida**—Clay Colored Sparrow—Not rare, yet not what may be called common—It breeds along the Red river.

101. **Zonotrichia albicollis**—White-throated Sparrow—Common—Breeds here, especially northward.

102. **Z. leucophrys**—White-crowned Sparrow—Also breeds here, but is common along the Red river.

103. **Z. querula**—Harris' Sparrow—Not uncommon.

104. **Chondestes grammaca**—Lark Finch—Common.

105. **Passer domesti (curse) cus**—English Sparrow—More numerous than welcome.

106. **Passerella iliaca**—Fox-colored Sparrow—Not uncommon.

107. **Calmospiza bicolor**—LARK BUNTING—Common in the northwestern part of the State.

108. **Euspiza americana**—BLACK-THROATED BUNTING—Not a very constant or abundant species, but breeds here.

109. **Goniaphea ludoviciana**—ROSE-BREASTED GROSBEAK—A very common species.

110. **Cyanospiza cyanea**—INDIGO BIRD—Common for its species.

111. **Cardinalis virginianus**—CARDINAL RED-BIRD—An ocasional straggler—Has been obtained in pairs under circumstances to justify the record.

112. **Pipilo erythrophthalmus**—TOWHEE BUNTING—An average representation.

113. **Dolichonyx oryzivorus**—BOBOLINK—Common.

114. **Molothrus pecoris**—COW-BIRD—Very abundant.

115. **Agelæus phœniceus**—RED-WINGED BLACKBIRD—An abundant species.

116. **Xanthocephalus icterocephalus**—YELLOW-HEADED BLACKBIRD—Numerous in restricted localities.

117. **Sturnella magna.**—MEADOW LARK—Common.

118. **S. Neglecta.**—Common along the Red River and occasional in other sections.

119. **Icterus spurius.**—ORCHARD ORIOLE—A rather common and constantly observed species.

120. **I. baltimore.**—BALTIMORE ORIOLE—Very common.

121. **Scholecophagus ferrugineus.**—RUSTY BLACKBIRD—Seen only in migration.

122. **S. cyanocephalus.**—BREWER'S BLACKBIRD—Breeds in considerable numbers on the Red River.

153. **Quiscalus purpureus.**—CROW BLACKBIRD—Abundant.

124. **Corvus americanus.**—CROW—Not abundant, but is increasing in numbers.

125. **C. ossifragus.**—FISH CROW—Seen rarely in considerable flocks in migration.

126. **Pica melanoleuca, var hudsonica.**—Occasional.

127. **Cyanurus cristatus.**—BLUE JAY—Very common.

128. **Perisoreus canadensis.**—CANADA JAY—Met with frequently about Lake Superior.

129. **Tyrannus carolinensis.**—KING BIRD—Common.

130. **Myiarchus crinitus.**—GREAT-CRESTED FLYCATCHER—not common, but breeds here.

131. **Sayornis fuscus**—PHŒBE BIRD—Common.

132. **Contopus borealis**—OLIVE-SIDED FLYCATCHER—Rather a common flycatcher—breeds here.

134. **C. virens**—WOOD PEWEE—Quite common.

134. **Empidonax acadicus**—SMALL GREEN-CRESTED FLYCATCHER—Common in woodlands.

135. **E. traillii**—TRAILS' FLYCATCHER—Rare.

136. **E. minimus**—LEAST FLYCTCAER—Not common.

137. **E. flaviventris**—YELLOW-BILLED FLYCATCHER—Not abundant. but fairly represented.

138. **Chordeiles virginianus**—NIGHTHAWK—Common.

139. **Antrostomus vociferus**—WHIPPOORWILL—Common.

140. **Chœtura pelasgia**—CHIMNEY SWIFT—Abundant.

141. **Trochilus colubris**—RUBY-THROATED HUMMING-BIRD—An average representation.

142. **Ceryle alcyon**—KINGFISHER—Common.

143. **Coccyzus erythrophthalmus**—BLACK-BILLED CUCKOO—Common

144. **C. americana**—YELLOW-BILLED CUCKOO—Not common.

145. **Hylatomus pileatus**—PILEATED WOODPECKER—Not an abundant but fairly represented species.

146. **Picus villosus**—HAIRY WOODPECKER—Common.

147. **P. pubescens**—DOWNY WOODPECKER—Not quite as common as the last.

148. **Picoidie arcticus**—BLACK-BACKED-THREE-TOED WOODPECKER—A rare winter species.

149. **Sphyrapicus varius.**—YELLOW-BELLIED WOODPECKER—Not very abundant.

150. **Melanerpes erythrocephalus.**—RED-HEADED WOODPECKER—Very common in sections.

151. **Colaptes auratus.**—GOLDEN-WINGED WOODPECKER—Very common.

152. **Strix flamea var americana.**—BARN OWL.—In a former list I erroneously reported this owl as common.—It is a very rare species here although several have been obtained by collectors.—No nests as yet seen.

153. **Rubo virginianus.**—GREAT-HORNED OWL.—Common.

154. **Scops asio.**—SCREECH OWL—Not very common.

155. **Otus vulgaris var wilsonianus.**—LONG-EARED OWL.—Rather a common species.

156. **Brachyotus palustris.**—SHORT-EARED OWL.—Not rare.

157. **Syrnium cinereum**—GREAT GRAY OWL—This huge species is *not* very common in Minnesota.

158. **S. nebulosum**—BARRED OWL—generally found in summer when it is common.

159. **Nyctea nivea**—GREAT WHITE OWL—Seen frequently in winter.

160. **Surnia ulula var hudsonia**—HAWK OWL—Often collected in early spring.

161. **Nyctale telgmalmi var richardsoni**—RICHARDSON'S OWL—neither common nor very rare.

162. **N. acadica**—SAW-WHET OWL—Frequently seen in the forests.

163. **Circus cyaneus•var hudsonius**—MARSH HAWK—The commonest of its eastern family.

164. **Nauclerus furcatus**—SWALLOW-TAILED HAWK OR KITE—Often seen in the densest forests.

165. **Accipiter fuscus.**—SHARP-SHINNED HAWK—Quite common, but less so than the next species.

166. **A. cooperii.**—COOPER'S HAWK—Breeds here extensively.

167. **Astur atricapillus.**—GOSHAWK—Not abundant, but fairly represented.

168. **Falco gyrfalco var labradora.**—GERFALCON—Rare.

169. **F. communis.**—DUCK HAWK,—Cannot be said to be very common, yet is often seen.—Breeds in the State.

170. **F. columbarius.**—PIGEON HAWK.—Rather rare.

171. **F. richardsonii.**—RICHARDSON'S FALCON,—Occasional.

172. **F. sparverius.**—SPARROW HAWK,—Very common.

173. **Buteo borealis.**—RED-TAILED HAWK,—Common.

174. **B. lineatus.**—RED-SHOULDERED HAWK,—Not so common as the Red-tailed Hawk.

175. **B. swainsonii.**—SWAINSON'S HAWK,—Not uncommon in the west part of the State.

176. **B. pennsylvanicus.**—BROAD-WINGED HAWK,—Rather a common buzzard.

177. **Archibuteo lagopus var sancti-johannes.**—Rare.

178. **Pandion halicetus.**—OSPREY OR FISH-HAWK.—A moderately represented species.

179. **Aquila chrysaetus.**—GOLDEN EAGLE.—Rare.

180. **Halicetus leucocepalus.**—BALD EAGLE—Common.

181. **Cathartes aura.**—TURKEY BUZZARD—Not common.

182. **Ectopistes migratorius.**—WILD PIGEON—Extremely variable—never quite abundant.

183. **Zenadura carolinensis.**—COMMON DOVE—Common.

184. **Meleagris gallopavo var. americana.**—Only found in the extreme southwestern part of the State and then very rarely.

185. **Tetrao canadensis.**—CANADA GROUSE—Northeastern part of the State.

186. **Pedicecetes phasianellus.**—SHARPTAILED. GROUSE—Common in northeastern and northern portions.

187. **Cupidonia cupido.**—PINNATED GROUSE—Commom.

188. **Bonasa umbellus.**—RUFFED GROUSE—Common.

189. **Lagopus albus.**—WILLOW PTARMIGAN—Rare.

190. **Ortyx virginianus.**—QUAIL—Becoming more common but not yet abundant.

191. **Squatarola helvitica.**—BLACK-BELLIED PLOVER—Rather common in both migrations.

192. **Charadrius fulvus var virginianus.**—GOLDEN PLOVER—Abundant in migration.

193. **Ægialitis vociferus.**—KILLDEER PLOVER—Common.

194. **A. semipalmata.**—RING PLOVER—Fairly common.

195. **Strepsilas interpres.**—TURNSTONE—Not common but well identified.

196. **Recuvirostra americana.**—AVOCET—Rare or not common.

197. **Himantopus nigricollis.**—STILT—Not very common, nor yet rare.

198. **Steganopus wilsonii.**—WILSON'S PHALAROPE—A moderately represented species.

199. **Lobipes hyperboreus.**—NORTHERN PHALAROPE—Not as frequently seen as the last.

200. **Phalaropus fulicarius.**—RED PHALAROPE—Rare.

201. **Philohela minor.**—WOODCOCK—Not abundant, yet frequently seen.

201. **Gallinago wilsonii.**—WILSON'S SNIPE—Common.

202. **Macrorhampus griseus.**—RED-BREASTED SNIPE—Rare.

203. **Micropalma himantopus.**—STILT SANDPIPER—Occasionally seen.

204. **Ereunetes pusillus.**—SEMIPALMATED. SANDPIPER—About same as last.

205. **Tringa minutilla.**—LEAST SANDPIPER—Common.

206. **T. maculata.**—JACK SNIPE—Common.

207. **T. alpina.**—RED-BACKED SANDPIPER—Common.

208. **Calidris arenaria.**—SANDERLING—Rare.

209. **Limosa fedoa.**—GREAT MARBLED GODWIT—Not rare, but not common except in the extreme northwest part of the State.

210. **Totanus semipalmata.**—WILLET—Same as last.

211. **T. melanoleucus.**—GREATER TELLTALE—Not rare.

212. **T. flavipes.**—LESSER TELLTALE—Common.

213. **T. solitarius.**—SOLITARY SANDPIPER—Rather common.

214. **Tringoides macularius.**—SPOTTED SANDPIPER—Common.

215. **Tryngites rufiscens.**—BUFF-BREASTED SANDPIPER—Rather rare.

216. **Numenius longirostris.**—LONG-BILLED CURLEW—Common along the Red river.

217. **N. hudsonicus.**—HUDSONIAN CURLEW—Less common.

218. **N. borealis.**—ESQUIMAUX CURLEW—Not rare.

219. **Ardea herodius.**—GREAT BLUE HERON—Common.

220. **A. egretta.**—WHITE HERON—Occasional.

221. **A. candadissima.**—SNOWY HERON—Very rarely seen.

222. **A. virescens.**—GREEN HERON—Common.

223. **Nyctiardea grisea, var. nævia.**—NIGHT HERON—Not rare.

224. **Botaurus minor.**—BITTERN—Very common.

225. **Aradetta exilis.**—LEAST BITTERN—Common.

226. **Grus americana.**—WHITE CRANE—Not very common birds here.

227. **G. canadensis.**—SANDHILL CRANE—Common.

228. **Rallus elegans.**—KING RAIL—Occasional.

229. **R. virginianus.**—VIRGINIA RAIL—Common.

230. **Porzana carolina.**—SORA RAIL—Very common.

231. **P. noveboracensis.**—YELLOW RAIL—Rather rare.

232. **Gallinula galeata.**—FLORIDA GALLINULE—Not common, but breeds in the Minnesota River bottoms.

233. **Fulica americana.**—COOT—Abundant throughout the state.

234. **Cygnus buccinator.**—TRUMPETER SWAN—Common in migration along the Red River where it breeds to some extent.

235. **C. americanus.**—WHITE, OR WHISTLING SWAN—Common in some regions where it breeds.

236. **Anser albifrons var. gambelli.**—WHITE FRONTED GOOSE—Probably stragglers but represented.

237. **A. hyperboreus.**—SNOW GOOSE—abundant in the autumn migrations.

238. **A. coerulecens**—BLUE GOOSE.—Often seen in the Red River region in migration.

239. **Branta bernicla.**—BLACK BRANT—Not really common nor specially rare.

240. **B. canadadensis.**—COMMON WILD GOOSE—Abundant.

241. **B. hutchinsii.**—HUTCHIN'S GOOSE—Less common.

242. **Anas boschas.**—MALLARD—Abundant.

243. **A. obscura.**—BLACK DUCK—Rather common.

244. **Dafila acuta.**—PINTAIL DUCK—Common in its migrations.

245. **Chaulelasmus streperus.**—GADWALL DUCK—Common.

246. **Mareca americana** WIDGEON—Equally common.

247. **Querquedula carolinensis.**—GREEN-WINGED TEAL—Abundant in migrations and breeds in considerable portions of the State.

248. **Q. discors.**—BLUE-WINGED TEAL—Also abundant in migrations and breeds here.

249. **Q. cyanoptera.**—CINNAMON TEAL—Very rare straggler.

250. **Spatula clypeata.**—SHOVELLER DUCK—Breeds here, and is common.

251. **Aix spona.**—WOOD DUCK—Abundant breeder here.

252. **Fuligula marila.**—BLUE-BILL—An abounding species in both migrations and probably breeds here.

253. **F. affinis.**—LITTLE BLACK-HEAD—About as last.

254. **F. collaris.**—RING-NECKED DUCK—Not abundant except in occasional seasons.

255. **F. valisneria.**—CANVAS-BACK DUCK—Not usually very abundant, but breeds here.

256. **F. ferina, var. americana**—RED-HEAD DUCK—About like the last—not yet certainly known to breed here.

257. **Bucephala clangula.**—GOLDEN-EYE DUCK—Not uncommon in migration.

258. **B. albeola.**—BUTTER-BALL DUCK—Abundant, and is believed to breed in the northern section of the State.

259. **Harelda glacialis.**—Small flocks occasionally met in full migration.

260. **Œdemia americana.**—BLACK SCOTU—rare.

261. **Erismatura rubida.**—RUDDY DUCK—Not very common, but breeds here.

262. **Mergus merganser.**—SHELLDRAKE—Common, and breeds here.

263. **M. serrator.**—RED-BREASTED MERGANSER—Also common, and breeds here.

264. **M. cucullatus.**—HOODED MERGANSER—Like the last two, common, and breeds here.

265. **Pelicanus trachyrhynchus.**—WHITE PELICAN—Common, breeding in colonies—in retired sections.

266. **Graculus carbo.**—COMMON CORMORANT—rare.

267. **G. dilophus.**—DOUBLE-CRESTED CORMORANT—More common, but not numerous.

268. **Larus argentatus.**—HERRING GULL—Common in migration.

269. **L. delawarensis.**—RING-BILLED GULL—Not uncommon.

269. **L. trydactylus.**—KITTIWAKE GULL—Not common.

270. **L. atricilla.**—LAUGHING GULL—Reported, but doubtful.

271. **L. franklini.**—FRANKLIN'S GULL—rare but identified.

272. **L. philadelphia.**—BONAPARTE'S GULL—More common.

273. **Sterna caspia.**—CASPIAN TERN—Several collected.

274. **L. forsteri.**—FORSTER'S TERN—Common, and breeds here.

275. **S. superciliaris var, antillarum.**—LEAST TERN—Not rare, probably breeds here.

276. **Hydrochelidon lariformis.**—BLACK TERN—Very common, and breeds here extremely.

277. **Colymbus torquatus.**—LOON—Very common.

278. **C. septentrionalis.**—RED-THROATED DIVER—Rare.

279. **Podiceps coruntus.**—HORNED GEEBE—Common.

280. **P. griseigena var, hoebollii.**—RED-NECKED GEEBE—Not common, but breeds here.

281. **Podilymbus podiceps.**—DABCHICK—Common.

THE WINTER BIRDS OF MINNESOTA.

BY THOMAS S. ROBERTS.

Prof. N. H. Winchell:

The question is often asked "How many kinds of birds are there in Minnesota in the winter time?" and supplemented not infrequently by the remark "not many, I suppose." There seems to be no more appropriate place for the answering of this question at length as it deserves than in the annual report of the survey. The present article is therefore respectfully submitted as an attempt to list our winter birds so far as they are known to the writer at the present time, with the introduction of such brief notes, mainly of a popular nature, in regard to the occurrence, habits or appearance of each species as may assist in its identification or be of interest otherwise.

The much greater abundance and attractiveness of birds in the summer season is very apt to entirely absorb the attention of the casual observer and to lead to the almost complete neglect of our winter birds; especially as the latter are greatly diminished in numbers, are comparatively silent and are largely shielded from observation by the many drawbacks to outdoor investigation in the winter time. But because the birds do not force themselves upon our attention in winter as they do in summer we ought not to conclude either that there are no birds present or that they are of little interest. The fact is that while birds are generally far from abundant in the cold season, particularly in respect to individuals, there are yet a goodly number of species to be found within the limits of the State. And among these every lover of birds cannot fail to find a number which are of much more than average interest. Birds which are attractive either in themselves on account of their beautiful or varied plumage, or by reason of

curious and perhaps little known habits, or through having interesting personal histories recorded in the pages of our ornithologies.* The only opportunity to become acquainted with such birds as the handsome and little known evening grosbeak, its relative, the pine grosbeak, the elegant northern waxwing or the more common but little less interesting red-poll linnet, snow bunting and Lapland longspur, is during their sojourn here as visitors from their far northern summer homes. Moreover those birds that are present in the summer, have, in winter, to live and gain their livelihood under greatly changed conditions which presents them to the observer in new and generally very different aspects. The winter then offers a field for study peculiarly its own—not a rich and almost endlessly varied one like that of the summer and transition seasons, but yet a field amply repaying the outlay of time and effort necessary to become acquainted with its prominent features.

A word may be said here in reference to a noticeable trait of many winter birds which renders their observation all the easier if one is but looking for them. It is the preference often shown for the vicinity of dwellings, towns or even busy cities over the wild and unsettled country. The jays, grosbeaks, waxwings, sparrows and even hawks and owls are more likely to be found in the near vicinity of human habitations than elsewhere. The greater ease and certainty with which food and shelter can be obtained is no doubt the reason for this.

The probable number of birds constituting the avi-fauna of Minnesota is in the near neighborhood of three hundred. Of this number about two hundred and seventy-five species have thus far been collected or otherwise identified. About fifty species are known to occur in the State in the winter months. Of these a few are accidental: some are rare birds everywhere and at all times; while others are found only during occasional winters. There is scarcely the least probability that all would occur at any one locality: nor is it very probable that the whole number occur within the limits of the State during a single winter. An experience extending through several winters differing in character, together with a residence in different parts of the State, would therefore be necessary to form the winter acquaintance of all these birds.

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*Entertaining accounts of all the birds so briefly mentioned below may be found by reference to such works as Audubon's, Wilson's, and Nuttall's Ornithologies, Cone's Birds of the Northwest, Baird, Brewer and Ridgway's Birds of North America and numerous other minor works of a more popular nature, among which may be mentioned the writings of John Burroughs. The latter's "Wake Robin" is a little book full of charming bird biographies.

For the purpose of showing at a glance the manner of their occurence, our winter birds may be divided into groups somewhat as follows: *First*—Permanent residents, or those birds found in the State the year round; *Second*—Winter visitants, including such birds as come into the State from the north to pass the winter season; *Third*—What might be called, adopting a florist's term, "Half-hardy species," embracing those birds found regularly during mild winters or which appear during mild weather in the latter part of January and in February; and lastly, a few species that are purely accidental.

In the following lists, the species belonging to each of these groups are given in their natural order. It should be said, however, that in the case of two or three species the positions they hold are only provisional; as for example it is quite possible that both the hawk, owl and goshawk may breed in the northern part of the state, in which case they should be placed among the permanent residents instead of with the winter residents as below.

PERMANENT RESIDENTS.

1. **Parus atricapillus,** (*Linn.*) (BLACK-CAPPED CHICKADEE.)—A common, cheery little bird found almost everywhere, and known by sight and name to nearly every one who notices birds at all. They spend the winter in small companies which rove through the woods and thickets and not infrequently appear in the very centers of our cities and towns. The severest cold seems only to increase, if possible, their activity and bustle.

2. **Sitta caroliaensis,** (*Lath.*) WHITE-BELLIED NUTHATCH.)—A small, bluish, black-capped, white-bellied bird sometimes, though incorrectly, called "sapsucker." In common with the following species it spends its time creeping over the limbs and trunks of trees in search of food, wood-pecker-like, and so is often regarded as a small member of that family. It is not, however, related to the woodpeckers, and even its scansorial habits it will be found by a close observer to differ very much from those birds. The nuthatch is a common bird, of confiding and familiar habits and may be seen regularly about our streets and yards as well as in more retired localities. They are almost always in pairs and apparently remain constant throughout the year.

3. **Sitta canadensis,** *Linn.* RED-BELLIED NUTHATCH.—Smaller than the last and rusty colored beneath. Seldom found in winter in the southern part of the state where, however, it is frequent in fall and

spring. Mr. T. M. Tripple has recorded it as common in the central part of the state in December 1870.

4. **Loxia leucoptera.** *Gm.* WHITE-WINGED CROSSBILL.—Apparently much less common than the next, from which it may be distinguished by the presence of two white bars on the wing.

5. **Loxia curvirostra americana.** (*Wils.*) *Cones.* RED-CROSSBILL.—The crossbills are birds found almost exclusively in or near the coniferous forests of the State, as their food is largely obtained from the cones of evergreens. The name comes from the fact that the upper and lower mandibles are curiously crossed somewhat like the parts of a pair of scissors. It is this structure of the bill that enables the bird to remove the seeds from among the rough scales of the cones. The present species is common and a small flock of stragglers is sometimes seen in the neighborhood of Minneapolis and St. Paul, away from their usual habitat.

6. **Passer domesticus.** ENGLISH SPARROW.—This unwelcome alien appeared in Minnesota in the fall of 1876, having been previously introduced into St. Paul, I understand. It has not increased here in its usual extraordinary manner, owing in great part, doubtless, to our severe winters and late springs. At Minneapolis they have confined themselves, as yet, entirely to the business part of the city, where they build their large unsightly nests in all conceivable situations.

7. **Corvus corax.** *Linn.* RAVEN.—Common in the northern and central part of the State.

8. **Cyanurus cristatus.** (*Linn.*) Sw. BLUE JAY.—In the south-eastern part of the State, a common bird familiar to every one. Of a bold and inquisitive disposition the Jay forages about our door yards and outbuildings, prying into every nook and corner, but never forgetting for an instant to be on his guard against any impending danger.

9. **Perisoreus canadensis.** *Bys.* CANADA JAY.—Abundant and well known in the pineries and more northern parts of the State under the various names of moose bird, whisky jack, carrion jay, meat bird, etc. It is even more bold and fearless than its blue-coated brother, and lives about the lumber camps and farm houses on the most intimate terms with all connected pith the culinary department. It is possessed of a ravenous appetite, and is quite omnivorous in taste, though scraps of meat of any kind are always preferable morsels. It seldem, if ever, appears in the southern part of the State.

10. **Hylotomus pileatus.** (*Linn.*) *Bp.* PILEATED WOODPECKER.—The largest of our woodpeckers, and with a single exception, the largest found in North America. It is nearly the size of a crow, mainly black and with a gorgeous scarlet cap and crest. "Logcock" is its common appellation. In heavy timber throughout the State it is a rather common bird and stragglers are likely to occur whenever the country is not actually prairie or brush land.

11. **Picus villosus.** *Linn.* HAIRY WOODPECKER.—Common. Colors, black and white, with red on the head in the male.

12. **Picus pubescens.** *Linn.* DOWNY WOODPECKER.--Common. In marking almost exactly like the last, but only about one half the size. These two wookpeckers perform a service of incalculable value to man by the untiring warfare they wage upon the insects destructive to shrub and tree. All winter long they may be seen beside the walk, upon the lawn or in the more retired groves of the suburbs industriously at work upon the infected tree; and their very presence proves the existence of the insects or their eggs. The name Sapsuker is applied to these birds, but it is not deserved. They are naturally neither sap or bark eaters. The real culprit is the yellow-bellied woodpecker. *Sphyrapcius* (*rarious*), a bird that drills large holes entirely through the inner layer of bark and thus allows the sap to run out, often in considerable quantities. I have seen sugar maple trees tapped in this way and the whole lower part of the trunk of the tree saturated with the sap that oozed out. The bird is fond of the sap and may be frequently seen clinging to the hole of the tree and drinking the liquid that collects in the punctures. The yellow-bellied woodpecker is not a winter resident, but is common in the timber at other seasons of the year.

13. **Picoides arcticus** (*Sw.*) *Gray.* ARCTIC WOODPECKER.—A rather common bird in some parts of the State, but only a straggler in the vicinity of Minneapolis. It displays a preference for old tamarack swamps in more or less heavily timbered country. It may be known by the uniform black of the upper parts, a square yellow patch on the crown in the male and the fact that it has but three instead of four toes. Its congener, the banded woodpecker (*Picoides Americanus*) is also a three-toed species but the back is banded with white. It has not yet been reported from Minnesota, though it probably occurs here rarely.

14. **Bubo virginianus** (*Gm.*) *Bp.*—GREAT-HORNED OWL.—The largest of our owls with "horns"—tufts of lengthened feathers on the head. Frequently met with in heavy timber.

15. **Scops asio** (*Linn*) *Bys.*—SCREECH OWL.—A small horned owl, about nine inches in length. Apparently not common-

16. **Nyctale acadica** (*Gm.*) *Bys.*—ACADIAN OR SAW-WHET OWL.—A diminutive bird only about seven and a half inches in length. Not common.

17. **Aquila chrysaetus,** *Linn.*—GOLDEN EAGLE.—A rare bird and but little is known of its occurrence here winter or summer. It is introduced here since it is known to occur in the summer and is usually resident where found.

18. **Haliaetus leucocephalus,** (*Linn*) *Sar.* WHITE-HEADED OR BALD EAGLE.—Occasionally occurs in the winter. An adult bird seen flying over Minneapolis, Jan. 1, 1879. (The two eagles may be distinguished in any plumage by noticing the feathering on the legs; in the golden eagle it extends to the base of the toes, while in the bald eagle the lower part of the tarsus or "shank" is bare.)

19, **Tetrao canadensis.** *Linn.* CANADA OR SPRUCE GROUSE.—Found in the evergreen woods of the northern and central parts of the State.

where it is rather common. It is generally unfit for food, owing to the rank taste and odor imparted to the flesh by the leaves of spruce and other evergreens upon which it feeds.

20. **Pediocetes phasianellus columbianus.** (*Ord.*) *Coues.* SHARP-TAILED GROUSE.—Common, except in the southeastern part of the State. Not found about St. Paul and Minneapolis, except accidentally. It is an excellent food bird, the flesh being lighter in color than that of the prairie hen or pinnated grouse. It may be readily distinguished from the latter, not only by the marked difference in the pattern of coloration, but by the presence of two lengthened feathers in the centre of the tail, from which character it takes its name. Great numbers of the sharp-tailed game are sold in our markets every season.

21. **Cupidonia cupido** (*Linn.*) *Bd.* PINNATED GROUSE.—Found throughout the State where not timbered, except, perhaps, a small area in the northwestern part. As winter approaches the pinnated grouse collect in vast flocks, called "packs", and during severe seasons many apparently retire to the corn fields and milder climate of Iowa.

22. **Bonasa umbellus** (*Linn*). *Steph.* RUFFED GROUSE.—Common, and well known by both the names pheasant and partridge, neither of which, however, belong properly to this bird. The ruffed grouse has greatly decreased in numbers in the more settled parts of the State during the last few years.

23. **Ortyx virginianus** (*Linn.*) *Bp.* QUAIL BOB-WHITE.—Rather common in the southern part of the State, but our severe winters and continuous snows prevent them becoming very numerous.

WINTER VISITANTS.

24. **Ampelis garrulus** *Linn.* NORTHERN WAXWING.—An irregular, though at times abundant visitor from the north. It usually appears in the northern part of the State from November 15, to December 15, and remains until the middle or latter part of April. (April 25, 1876; April 12, 1877; April 14, 1880.) * It sometimes appears in abundance in March and April, when it has not been seen during the previous winter, as in the spring of 1877.

They associate in flocks often of large size, and during their sojourn here live chiefly about our towns and cities, being quite tame and unsuspicious. Their beautiful crest and rich, smooth plumage gives them a jaunty, trim appearance, which has brought them into more general notice than perpaps any other one of our winter birds. The resemblance between the northern waxwing and the common cedar or cherry bird is so close, that many persons are only convinced that they are distinct after a close comparison of specimens. The present bird is larger and darker than its summer representative and has on the wing, in addition to the red wax-like appendages, common to both species, considerable white and often some yellow markings. The two species may sometimes be seen in early spring associating together in

* When no locality is specified, dates refer to the vicinity of Minneapolis.

the same flock. The food of the northern birds while here consists of mountain ash berries, wild grapes, smilax berries, wolf-berries, high-bush cranberries, decayed fruit, especially apples, thrown out from stores or kitchens and such other palatable vegetable substances as they can find. But as spring opens, their food becomes largely insectivorous, and their habits accordingly undergo a marked change. They are no longer so familiar or such frequent visitors to back yards and alley ways; but are instead much more retiring and refined in habits. They capture the insects on the wing in the manner of flycatchers, and a whole flock may often be seen thus engaged for an hour or more at a time. Examination has shown that the insects just taken consist mainly of minute coleoptera, thousands ef which must appear in the air with the disappearance of the snow.

25. **Hesperiphona vespertina**, (*Coop.*) *Bp.* EVEVING GROSBEAK.—A quite regular visitant but rather local in distribution and limited in numbers. It generally arrives in the southeastern part of the State in the early part of December, but sometimes much earlier, as in the fall of 1880, when the writer saw a flock of five in Isanti Co., on Oct. 28. It is one of the last of the winter birds to retire, remaining usually until the second or third week in May. (May 17, 1876, May 16, 1877, May 18, 1879.)

The male evening grosbeak is a beautiful bird being arrayed in a plumage of black, white, yellow and a peculiar "dusky olive," the colors handsomely contrasted or evenly shaded the one into the other. The female is much plainer, but the species may always be recognized by the short but very large conical bill, which ic generally greenish horn color.

Like the wawings the grosbeaks appear to court rather than shun the society of man. They are very tame aud will spend an entire season about a city, having their headquarters at some central grove and frequenting the busiest thoroughfares to feed with entire unconcern upon the box-elders planted by the walk as shade trees. It is from the keys of the box elder and sugar maple that they derive their chief sustenance, and it is surprising to see the adroitness with which they remove the tiny kernel from its dry husk with their clumsy looking bill. Their principal utterance is a clear piping note delivered with much energy by male and female alike. They have also a weaker, screaming note which usually serves as an accompaniment or undertone to the general choral performance which is their most common way of expressing themselves when settled in some quiet spot. As a friend remarked upon listening for the first time to one of their united efforts, the general effect is very much like that produced by a lot of frogs piping in a woodland marsh on a still summer evening. There is an unread chapter in the history of the present bird, which, together with the fact that it is nowhere very common, causes it to be of more than usual interest to the ornithologist. Its nest and to a great extent its summer home and habits are as yet unknown.

26. **Pinicola enucleator** (*Linn*) *Cab.*—PINE GROSBEAK—A bird a little less in size than the robin; slate colored, with brassy yellow or reddish

on the head and rump in the female and immature birds, but the adult male carmine red nearly throughout when in full plumage. It is of irregular occurrence, being quite numerous some winters and then almost entirely absent for several winters together. During the winter of 1874–5 they were common in flocks about Minneapolis and were quite well represented during the winter just passed (1880–1). They appear in the latter part of November or early in December and leave in March (Mar. 13, 1875; Mar. 7, 1879). They have a mellow, sweet whistle, aud while here, a low, subdued song. Their food consists largely of sumach berries, mountain ash berries, high-bush cranberries, etc., but it is the seeds not the pulp of the berries of which they are fond. They reject entirely the pulp of the high-bush cranberry, simply pressing out and eating the single broad, flat seed.

27. **Ægiothus linaria** *(Linn) Cab.* RED-POLL LINNET—A sprightly little bird with a black chin patch and a dark crimson on the top of the head with sometimes a rare red plush over the entire heart. It is very abundant some seasons, appearing in large flocks and frequenting weedy fields and tamarack swamps. They appear about the first of November aud remain until the middle of April (April 18, 1875).

28. **Plectrophanes nivalis,** *(Linn.) Meyer.* SNOW BUNTING.—Common. Generally most numerous in late fall and early spring. Arrives in the latter part of October (one taken Oct. 16, 1875) and generally leaves in April, though stragglers are sometimes found in May (a pair, male and female, apparently mated, taken at Minneapolis May 14, 1875, and one seen May 5, 1876). A bird a little less in size than a bluebird, plumage much variegated with black, white and and reddish brown in the fall and winter but becoming mainly black and white in sharply defined areas in spring. Breeds within the Arctic Circle.

29. **Plectrophanes lapponicus,** *(Linn.) Selby.* LAPLAND LONGSPUR.—Similar to the last but much darker in color. The hind claw is very long, from which comes the name. The snow bunting and Lapland longspur are highly gregarious birds and during the fall, early spring and mild winters they often occur in countless thousands, frequenting prairies and fields where they feed upon the ends of grasses and weeds. The longspur appears in Hennepin Co. as early as September (taken Sept. 29, 1875; seen Sept. 30, 1880) and leaves in late April, though like the snow bunting it is occasionally found in May (three taken May 3, 1875, and a flock seen May 11, 1877).

30. **Spizella monticola,** *(Gm.) Bd.* TREE SPARROW.—A small, brownish bird with a dark spot on the breast and an unbroken rufus crown patch. An abundant migrant spring and fall, and some of the hardier birds remain here in sheltered places through the winter, though they are most noticeable mild seasons.

31. **Surnium cinereum,** *(Gm.) Aud.* GREAT GRAY OWL.—An immense, hornless owl occasionally taken in the state, but far from common.

32. **Nyctea scandiaca,** *(Linn.) Newt.* GREAT WHITE OR SNOWY OWL.—A well-known and wary bird which, while not exactly common, is yet generally and regularly distributed in open country. Taken at

Minneapolis Oct. 15, 1876, and stays sometimes in the southern part of the state until the second week in May.

33. **Surnia ulula hudsonia,** (*Gm.*) *Coues.* HAWK OWL.—A medium-sized owl of diurnal habits. So far as noticed it is uncommon in the southern part of the state, though it may be more numerous and breed in the northern, timbered part. Taken at Minneapolis Oct. 31, 1876, and again Dec. 1, 1876.

34. **Astur atricapillus,** (*Wils.*) *Jard.* GOSHAWK.—The hawk generally seen in winter. A bold and powerful bird that preys largely upon grouse and hares. Seen at Minneapolis Oct. 9, 1876, and young of year taken in Lake Co., Aug. 26, 1879.

35. **Bucephala islandica,** (*Gm.*) *Bd.* BARROW'S GOLDEN-EYE.—A beautiful black and white duck likely to occur wherever there is suitable open water. Several years ago, before the noise and activity became so great about the Falls of St. Anthony, a flock of these ducks used to spend the winter in the pool below the cataract. There is in the University Museum a female specimen of *B. islandica* taken at Minneapolis Jan. 13, 1877. Heretofore the *Bucephala* occurring in winter has been regarded as *clangula*, and while it is highly probable that that species does occur during the winter months, the only winter specimens that I have examined thus far is referable to *islandica*.

36. **Harelda glacielda** (*Linn.*) *Leach.*—LONG-TAILED DUCK—Occurs on Lake Superior. I have in my collection two specimens kindly sent to me by Mr. Thos. W. Mayhew, of Grand Marais, Cook Co. They were taken at that place, one April 12, 1880, and the other about March 1, 1881. In answer to an inquiry in regard to the occurrence of the species, Mr. Mayhew replied: "They are not considered rare here in winter. They make their appearance about October nearly every fall, and will remain all winter if the Lake is open; where they go when the Lake freezes I cannot say. I think they generally leave here about May. The Indians call them 'jack owly.'"

37. **Œdemia fusca,** *Swaim.* VELVET SCOTER COOT.—On two occasions I have seen ducks, evidently this species, in the river at Fort Snelling, once in January and once in April.

"HALF-HARDY."

All the species (except *Lanius borealis?*) here included under this head breed in the State, and when the winters are mild occur throughout the the year.

38. **Certhia familiaris.** *Linn*—BROWN CREEPER.—A very small, inconspicuous bird that is quite generally overlooked. May be known by its small size, dull markings, and habit of creeping up the trunks and limbs of trees. In its search for food it always begins at the base of the tree and passes spirally upward, probing every small hole and crevice with its fine, curved bill. Although sometimes found when the weather is quite severe, it is never numerous in the winter. (Dec. 10, 1874; Jan. 19, 1877: Feb. 23. 1878.)

39. **Eremophila alpestris** (*Forst.*) *Boie.*—HORNED LARK.—A bird of the prairie and open country, recognizable by the black and yellowish-white markings on the head, and black crescent on the breast, together with its quiet and unsuspicious nature. It frequents roads along which it collects a large part of its food. When the season is favorable, the sometimes larks appear in January, and by the last of February, have become numerous and are even paired and attending to nesting duties, as in the mild February of 1878. They can endure severe cold, and their absence in early winter, or sometime the entire season, is due mainly, in seems to me, to a scarcity of suitable food while the snows are so frequent and continuous. As soon as the ground becomes bare and slightly mellow in patches, however small, thėy return and then have the coldest weather that comes.

40. **Lanius borealis** (*Vieill*).—GREAT NORTHERN SHRIKE OR BUTCHER BIRD.—A bird about the size and general appearance of a mocking-bird, except that it is stronger built and has a powerful hooked and toothed bill. More commonly seen in spring and fall, but occasionally occurs during winter.

41. **Carpodacus purpureus** (*Gm.*) *Gray.*—PURPLE FINCH.—Present at Minneapolis during the mild winter of 1877–8 and occurring rarely colder seasons (Feb. 20, 1876). Male purplish red, except wings and tail: female and young dull-colored streaked; about six inches in length.

42. **Chrysomitris pinus** (*Wils.*) *Bp.*—PINE LINNET.—A small dull colored bird with concealed sulphur yellow markings on the wings and tail. Sometimes common in December and occurring occasionally throughout the winter. (Dec 25, 1877. Feb. 2, 1878.)

43. **Chrysomitris tristris.** (*Linn.*) *Bp.*—THISTLE BIRD GOLDFINCH.—In winter a brownish bird with black wings and tail, but becoming bright yellow in spring. It has a querulous note, oft repeated, and toward spring a varied, pleasing song. It sometimes occurs during rather cold winters and is generally common until the middle of December. (Dec. 11, 1875, Jan. 4, 1877, Feb. 10, 1877.)

44. **Juncus hyemalis.** (*Linn.*) *Sol.* SNOW BIRD.—Dark slate-colored, sharply contrasted on the breast with the bright white of the under parts. Seldom seen during winter. (Feb. 10, 1876, Jan. 21, 1880.)

45. **Corvus americanus,** *Rud.* CROW.—Sometimes appears in considerable numbers in February.

46. **Buteo borealis,** (*Gm.*) *Vieill.* RED-TAILED HAWK, HEN HAWK.—Uncommon in winter, but after a week of mild weather in January or February it may sometimes be seen sailing about high up in the air.

ACCIDENTAL.

47. **Turdus migratorius,** *Linn.* ROBIN.—Have heard of one hardy-dispositioned bird that successfully passed the winter of 1877—8 about the farm of Mr. J. D. Grimes, near Minneapolis. The season, however, was unusually mild.

48. **Anothura troglodytes hyemalis.** (*Vieill.*) *Coues.* WINTER WREN.—I am not quite positive about this species as a winter bird, but think that I have somewhere a record of its occurrence in February, which I cannot now find.

49. **Quiscalus purpureus æneus.** *Ridg.*—CROW BLACKBIRD. Occasionally appears in the midst of cold winters, seeming much more at home than would be expected. (Flock of four, Jan. 13, 1876.)

50. **Pica melanoleuca hudsonica.** (*Sab*). *Coues.* MAGPIE.—A single bird of this species was seen by Mr. Nathan Butler of Minneapolis, in the southaestern part of Stearns county, about 1858. Other than this, I have been able to learn nothing definite in regard to its occurrence, although it is a bird not easily mistaken or overlooked; being fifteen to twenty inches in length, mainly black with white markings on sides below, and with an exceedingly long tail, the feathers of which differ much in length.

51. **Gallinago wilsoni.** (*Temm.*) *Bp.*—WILSON'S SNIPE. JACK SNIPE. —Individuals sometimes remain about spring, runs until the middle of December or even into January the coldest winters. (Dec. 15, 1875, Dec. 15, 1877, Jan. 17, 1879).

52. **Anas boschas.** *Linn.* MALLARD DUCK. I have been informed that this duck often remains in spring lakes along the Minnesota River, and I have myself seen it as late as Nov. 28, (1875) after a month of severe weather.

In addition to the fifty-two species of birds mentioned above, there are several others which it is more than probable are found in Minnesota in winter, but as the writer has no knowledge of their actual occurrence here, they are not included in the present list. Among these are the following three of which have already been attributed to the state:—banded three-toed woodpecker, Tengmalius owl, red-shouldered hawk, ptarmigan and two or three waterfowl that probably occur on Lake Superior. But even though this list be not entirely complete, it may serve, perhaps, to convey some idea of the nature of our winter avi-fauna or to fix the proper names of a few of the birds around us.

THOS. S. ROBERTS.

Minneapolis, Minn., March, 1881.

APPENDIX A.

DETERMINATION OF LATITUDE AND LONTITUDE IN MINNESOTA.

OFFICE OF U. S. LAKE SURVEY
DETROIT, MICH., Dec. 3, 1880.

Prof. N. H. Winchell, State Geologist, Minneapolis, Minn.:

SIR:—Your letter of the 26th ultimo requesting latitudes and longtitudes of points in Minnesota has been received. Absence has delayed an earlier reply.

In the following list the longitudes depend on that adopted for the Lake Survey Observatory at Detroit, as 83°-03'—03'60. The latitudes were determined directly by observations made with Zenith telescope, except the cupola of the University where both the latitude and longitude depend upon observations made at St. Paul.

	LATITUDE.	LONGTITUDE W. OF GREENWICH.
Primary triangulation station North Base, on Minn. Point near Duluth	46°-45'—28.32	92°-04'—33.00
Easterly corner Custom House, St. Paul	44°-56'—42.96	93°-05'—34.03
Cupola University of Minn., Minneapolis	44°-58'—39.28	93°-14'—10.53
Astronomical Post, Court House Yard, Red Wing	44°-33'—44.16	92°-31'—59.25
Spire Catholic church, Red Wing	44°-33'—44.64	92°-31'—49.66

Very respectfully yours,

C. B. COMSTOCK,

Major of Engineers, and Brig. Gen. U. S. A.

APPENDIX B.

THE CUPRIFEROUS SERIES IN MINNESOTA.

BY N. H. WINCHELL.

[*From the Proceedings of the American Association for the Advancement of Science for* 1880].

The red shales and sandstones interstratified with the igneous rocks of the cupriferous series along the shore of Lake Superior in Minnesota, show various tages and kinds of metamorphism. While in some places, as at Good Harbor bay, they are not much changed by contact with the igneous layers separating them, in other places, they show a broken stratification, and a tough and siliceous texture, as at Tischer's, near Duluth, where these beds are finely and angularly jointed, have a red color and sometimes a jaspery or conchoidal fracture. In other places they take on a dull brown color, passing to a greenish-brown, becoming slaty and firm, or when in close proximity to igneous dikes, becoming black, dense and basaltiform, as at points east of Grand Marais. In the segregation of minerals, the first to appear are calcite and laumontite. These are disseminated with varying abundance through the shaly layers, as well as through the aluminous and red conglomerates, as seen at the mouth of the Manitou river and at numerous other places. They gather in seams, or in certain parts of the mass, or in the form of amygdules throughout the thickness of the exposed layers. This formation of laumontitic amygdaloids is particularly noticeable in those layers whose thickness is from a foot or two to twenty-five or thirty feet, and sometimes several may be seen alternating in the same bluff, or in a few rods along the shore, with beds of undoubted doleritic rock, as on the west coast of Agate bay, where may be seen five layers of igneous rock with four alternating layers of crumbling, thin-bedded laumontitic amygdaloid, styled "volcanic grits" by Norwood.

These amygdaloids are very susceptible to the destroying action of the waves and of the atmosphere, and their disintegration is the immediate cause of many of the purgatories and isolated arched beds of traprock that ornament the north shore of lake Superior.

When the source and supply of the heat were more continuous, involving greater thicknesses of the sedimentary beds, the siliceous material was more thoroughly fused and disseminated among the other elements. The more limited supply of air and water at these greater depths, seems to have produced, at least is coincident with, a greater abundance of felspathic material, instead of calcite and the hydrous zeolites, throughout the sedimentary layers. Thus the whole is sometimes changed to a non-differentiated ferruginous felsite. When the process was carried a little farther, crystals of red orthoclase appear in the mass, or of orthoclase in the form of translucent adularia, as in the rock of the "great palisades." When the metamorphism is carried still farther, involving in its slower progress large thicknesses of the red sedimentary shales and sandstones, thep become almost wholly crystalline, as seen in the red bluff that incloses Beaver bay on the west, and in the red granite bluff a few miles east of Beaver bay. The relationships of these changes with one another, and to the igneous rock, are evident at numerous places along the shore between Duluth and Grand Portage, and on Isle Royale; and their significance and application to the stratigraphic geology of the northeastern part of the state are very important. On passing inland from the lake shore back of Grand Marais, and up the Devil's Track and Brulé rivers, the red semi-metamorphic slates of the shore can be followed over a wide extent of territory, gradually becoming more changed and crystalline, in receding from the lake shore. They pass into red granite and gneiss (hornblendic) which rises in conspicuous hills, and shows perpendicular exposures along the lakes and streams, sometimes several hundred feet high, as at Brulé mountain, and at Misquah lake (T. 64.1 W., Sec. 22). In some places this highly crystalline condition of this red formation is seen to give place suddenly to areas of igneous rock of a dark color, and showing a very different mineral composition, and then to return again. This takes place sometimes on the high hills, the two kinds of rock alternating superficially in irregular patches, as at Duluth, and at Duck lake and Frog Rock river on the portage trail from Little Saganaga lake to the head waters of the Temperance river, in the northeastern corner of the state. Sometimes the tilted red sedimentary beds seem to be overlain by the igneous rock and sometimes underlain by it, the red rock, when consisting of sandstone at first, having been hardened into a quartzite. Several tilted red quartzite hills, very similar to the quartzite hills at New Ulm and in Cottonwood and Rock counties, occur in this connection at Duck and Wind lakes, their relation to the igneous rocks being most perfectly exemplified. Sometimes this red quartzite becomes micaceous and also felsitic, as may be seen at Wind lake. The great extent and the more intense metamorphism of this red formation, in the country lying to the north and west of Lake Superior, accompanied by larger belts of the igneous rock, more coarsely crystalline, not only shows that the seat and source of the igneous action was there instead of in the basin of the lake, but also that it was longer continued. It implies also. that a similar modification of these beds may be looked for throughout the northwest. wherever the formation is known to have been upheaved by igneous forces, although the igneous rock itself may be wanting.

Northwest of Lake Superior the igneous rock forms the main watersheds, rising in two main ridges, or ranges of mountains that run southwestwardly, one known as the *Mesabi*, and one as the *Sawteeth mountains*, though the former name is not restricted to this belt of high land. The width of the belt of metamorphic red shales and sandrock, associated with the igneous rock, is about

thirty miles in a right line, extending from the head waters of the Brulé and Temperance rivers to the shore of Lake Superior. The Sawteeth range of mountains, which is that nearer the Lake Superior shore, dies away in passing to the southwest, and the Mesabi belt of igneous outflow approaches the lake shore, appearing at Duluth in the form of the "Rice Point Granite." The tilted red shales, conglomerates and sandstones at Fond du Lac, a few miles west of Duluth, are the same as those seen associated with the igneous rock all along the shore. They lie there on a white-quartz, pebbly conglomerate, of a few feet in thickness, which lies unconformably on the roofing slates of the Huronian, the same formation that succeeds to the red rock formation toward the northwest, at Ogishke Muncie and Knife lakes, northwest of Grand Marais.

The mineralogical characters of these belts of igneous rock, which form some of the main features of the topography, seem to ally them to the Norian rocks of T. S. Hunt, and to the Labradorite rocks of Canada. At least if they be not the western extension of those formations, then those formations have not yet been discovered in Minnesota. But several traverses have been made of the country northwest of Lake Superior, for the purpose of geological examinations without finding anything that is at all comparable to those formations if it be not the rock of these hill ranges. The rock consists generally of some feldspar, which at Duluth has been found to be labradorite in large per cent., and at some places constituting over ninety per cent. of the mass, with varying proportions of augite or magnetite, or magnetic menaccanite, with various accessory ingredients, or minerals that result from change. It is massive, firm, dark-colored, and rises in low mountain ranges, as already stated. If its relation to the red granites and gneisses with which it is accompanied were not so evident, by simply noting the changes from the lake shore northwestwardly, it would hardly be presumed to be a parallel of the igneous rocks of the coast, any more than the red gneisses and quartzites would be of the shales and sandstones that are interbedded with them at the coast. So far as yet examined, these Labradorite rocks contain no bands of limestone, which is due probably to the fact that the Cupriferous Series in the northwest is not known to contain any beds of limestone. In the absence of this element, and in this only, so far as can be judged by the writer, these Labradorite rocks seem to differ from the Labradorite rocks of the "Upper Laurentian" of Canada.

Inferentially, therefore, the so-called "Upper Laurentian" containing *Eozoon Canadense*, seems to parallelize with the igneous rocks of the Cupriferous Series, or rather with the modified interbedded sedimentary portions of it, and hence the *Eozoon*, instead of being truly a Laurentian organism, seems to be one of the Cambrian or Lower Silurian. The abundant graphite of the "Laurentian" which pointed the way to the prediction of organisms in that formation, is also found in the modified quartzites and shales of the Cupriferous Series in perhaps equal abundance in the State of Minnesota.

APPENDIX C.

AN ANCIENT OUTLET OF LAKE MANITOBA.

St. Paul, Minn., May, 25th, 1881

Professor Winchell, Minnesota State Geologist, Minneapolis, Minn.:

Sir:—The following items relating to a supposed outlet of Lake Manitoba into the Assiniboine river, and other data, I have gathered from old journals (1874) and note books. The information is not as complete as I would like, but whatever you find herein I can vouch for. All the elevations given in this communication are referred to a datum plane 100 feet below the bench mark on Higgin's store on Main street, Winnipeg, Manitoba, and which is thirty-four (34) feet above the level of Lake Superior. The lots mentioned as being on the banks of the Assiniboine River are those of the Canadian government surveys of half-breed claims, as shown on the maps of the Dominion land office in Manitoba.

In the Parish of Baie St. Paul's and a short distance west of the big bend in the Assiniboine River known as the Bay, a narrow strip of water about six miles long and in no place over a mile wide forms what I take to be the end of a former outlet of Lake Manitoba. It is known as Long Lake, and varies in depth from six inches to six feet. The south end is about a quarter of a mile from the river. It runs northerly about two and a half miles and then turns abruptly and runs a little north of west for about three and a half miles. At the west end of Long Lake a creek (Long Lake Creek) falls into the lake. Going up the creek we run nearly due west for about one and a half miles, then the creek takes a southerly bend for about two miles, then westerly about four miles. This is the course of the creek proper; from its head there is a depression with a north-westerly trend gradually rising, having several branch depressions running northerly and north-easterly, and southerly and south-westerly. The summit of this main depression is from two to four feet lower than any other point of the water-shed between Lake Manitoba and the Assiniboine River, with an approximate elevation of 150 feet above datum. The depression beyond the summit, and having the same trend, becomes more and more defined as we go on, until it forms a cooley, or dry run, which leads into a small branch of the

creek east of Portage creek, which, for the sake of distinction, I have called Dufferin creek and which falls into Lake Manitoba with a very slight current. The banks of this creek are low and shelving, having a slope of about 4 to 1. From the cooley before mentioned there are several branch cooleys, possibly connecting with branches of Portage creek. To explain why I am led to believe Long Lake to be the remains of an ancient water course, I will give the actual levels taken, referred to the datum line mentioned previously.

	Feet.
Elevation of Lake Manitoba and marsh surrounding south end	148.90
" " bottom of Dufferin creek at a point about one and a half miles south of township line	148.38
" " top of bank of Dufferin creek at same point	164.84
Dufferin creek is here about nine inches deep.	
" " lowest point of ridge. (approximately)	150.00
Elevation of Long Lake	136.85
" " Land, 15 chains from Long Lake, southeasterly	139.44
" " " 25 " " "	140.04
" " top of bank of Assinibonie river at centre of lot 142	146.28
" " Assiniboine river at centre of lot 142	134.13

The immediate banks of Long Lake Creek are from six to ten feet high, sloping 1½ to 1. The ground on the north slopes gradually upward to a gravel ridge for the first two miles. This ridge is probably six to eight feet above the immediate bank of the creek. The ground to the south also slopes gently upward, commencing to slope however some distance from the creek. The immediate banks of Long Lake are from six to ten feet high, sloping up gradually. At the south end of Long Lake there is a channel running westward for three miles, and then losing itself in the prairies. There is also a slight depression running southeasterly towards the river. The only objection that can be raised regarding this being an ancient outlet of Lake Manitoba, is that the immediate banks of the Assiniboine river are about nine feet above the present level of the water in Long Lake, but the ridges forming the channel of the supposed old watercourse are, I am strongly inclined to believe, in no place lower than fifteen feet above the level of Long Lake.

The following extracts may be found useful:

October 1, 1874. Elevation of B. M. on wall of second store below the Davis house, (Higgins' store) in Main street, Winnipeg—100 feet above datum elevation of B. M. on southeast corner of plinth of Fairbanks' weighing machine, about 100 yards south of Hudson Bay Company's store at Winnipeg is.. 95.59

Elevation of top of bank of Red and Assiniboine at junction	95.36
" " ordinary summer level of Assiniboine river	68.40
" " present level of Assiniboine river	65.79

NOTE.—The last two elevations were taken at the junction of the Assiniboine river with the Red river of the north.

Elevation of level of river Assiniboine at mouth of Colony creek	65.83
October 2, 1874. Elevation of river Assiniboine at road-crossing between lots 71 and 72, in parish of St. James	68.18
Elevation of river Assiniboine (ordinary summer level) at same point as above	68.97

Elevation of river Assiniboine (ordinary spring level) at same point as above 77.05

Elevation of river Assiniboine (ordinary spring flood) at same point as above 82.61

The summer, spring and flood levels are very rough, being pointed out by a settler and may not be relied on to one foot. Banks high and abrupt, composed of sand and clay in mechanical combination. Near the west end of lot 41 in the parish of St. James, a great number of boulders, from two to three feet in diameter of a decided granite nature appear on the north side of the river. Banks are twenty feet high, very abrupt, composed of clay and sand, mixed. An exposure of the bank of the Assiniboine river on the south side, near lot 53 in St. James' parish, shows five feet of loam and eight feet of sand. The sand evidently extends far below this. The stones in the river are principally lime and conglomerates, (with scattered basalt boulders.)

October 5th, 1874. Sturgeon creek, near its junction with the Assiniboine river, has no regular channel, the ground on all sides being cut up with sloughs. It is evidently a serious torrent, when swollen. Elevation of water level of Sturgeon creek, at bridge, about half a mile from Assiniboine river, 90.96 above datum. Elevation of water level of Assiniboine river, at mouth of Sturgeon creek (the boundary between the parishes of St. James and St. Charles), 83.34 above datum.

October 8th, 1874. Elevation of water level of Assiniboine river at the crossing of the "Winnipeg meridian," in the parish of Headingly, 94.50.

October 9th, 1874. Elevation of bank of Assiniboine river, at lots 202–203, in parish of St Francis Xavier, is 122.55. Elevation of top of secondary bank is 114.00, and elevation of water level of river at same point is 99.01 above datum.

October 13th, 1874. Exposure of north bank of Assiniboine river, near church of St. Francis Xavier:

12"	Decayed leaves and mould.
27"	Sand and clay, mechanically combined.
6"	Sand and mould—mould predominating.
60"	Sand and clay—clay predominating.
6"	Lime and sand.
9"	Sand and clay—sand predominating.
12"	Clay and sand—clay predominating.
48"	Clay and sand—equal mixture.
24"	Clay and a little sand.

Pure sand—bed of river.

Elevation of the top of bank five (5) chains below St. Francis Xavier church is 121.67. Elevation of water level of river Assiniboine, at same point, is 102.95.

October 20th, 1874. In lot 230, in Parish of Baie St. Pauls, the top of bank of river Assiniboine is 132.67 in elevation above datum. Elevation of water in river at same point is 117.15.

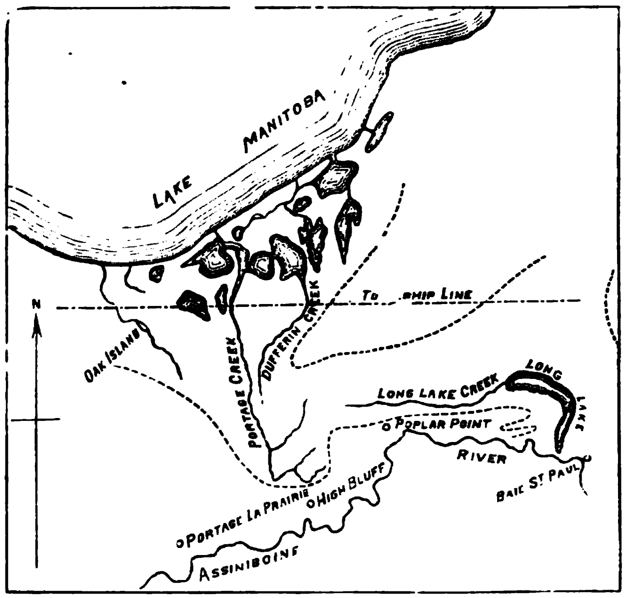
October 24th, 1874. Elevation of water-level of Long lake, in parish of Baie St. Pauls, 136.85. Elevation of land 15 chains S. E. from Long lake, 139.44. Elevation of land, 25 chains S. E. from Long lake, 140.04. Elevation of top of bank of river Assiniboine, at center of lot 142, in parish of Baie St. Pauls, 146.28. Elevation of water in river Assiniboine at same point, 134.13.

August 16th, 1875. The valley of the Assiniboine river at Fort Ellice is about a mile and a half wide, with very steep slopes. It seems to be one big marsh, in which any quantity of alders and willows flourish, and in which the winding river flows in its course. The river is nearly as broad and presents the same appearance as it does near Fort Garry. Elevation of B. M. on northwest corner of the Hudson Bay Company's store at Fort Ellice, 822.28.

Valley of the Assiniboine river at Fort Ellice is 220.5 feet deep. Valley of Snake creek, near Fort Ellice, and on an east and west line thereof, is 155.6 feet deep. Valley of Bird Tail creek, about twelve miles from Fort Ellice, and on an east and west line therefrom, is 150.65 feet deep.

I have the honor to be, yours very truly.

H. S. TREHERNE.



Approximate scale of six miles to ½ inch.

SKETCH MAP,

SHOWING THAT PORTION OF THE PROVINCE OF MANITOBA LYING BETWEEN LAKE MANITOBA AND THE ASSINIBOINE RIVER.

NOTE. Dotted lines show approximately the position of high ground.

INDEX

TO THE

GEOLOGICAL REPORT FOR 1880.

ERRATA FOR THE GEOLOGICAL REPORT FOR 1880.

[NOTE—These errata may be made in the Regents' Report by adding 90 to the paging given below.]

Page 11. At the end of the eleventh line add, vide No. 42.

13. Fourteenth line—for *nearly*, read mainly.

17. Fourteenth line—for *heavy-dark, green*, read heavy, dark-green.

21. Twenty-first line—for *their*, read thin.

21. The third line should be the first line.

41. Thirty-second line—for *and igneous*, read igneous and.

42. Thirteenth line—for *easily*, read evenly.

43. Thirty-fifth line—for *drift*, read dip.

46. Twentieth line—at the end of the line add, (?).

48. Next to the last line—after "up" insert, almost entirely.

49. Twenty-first line—for *Branch*, read Beach.

54. Lines thirty-four and thrity-six—for 314 and 315, read 214 and 215.

55. Tenth line—dele paragraph and read, No. 214 is of similar rock, etc.

56. Twelfth line—for *north*, read mouth.

60. Eighteenth line—for *there*. read these.

63. Fourteenth line—for *161*, read 261.

72. First line—for *(No. 5)*, read (N. & S.)

78. Next to last line—for "¼" read ½.

80. Thirteenth line—after "Duncan's lake," insert is.

82. Last line—for *927* read 727.

105. Twenty-sixth line—for *Vermilion Lake* read Lake Superior.

122. Next the last line—for *—3522 (199)* read 3522 (=199).

170. Thirtieth line—for *organic of the*, read of the organic.

224. Fourth line—for *is* read are.

224. Thirteenth line—after *raised* insert it.

234. Twenty-first line—for *from* read join.

~~288. The first four lines should be inserted before the last line on page 287.~~

~~287. The foot notes should exchange places.~~

390. The last two lines should appear as a heading, to explain the diagram on the next page.

Several minor errors will easily be corrected by the reader.

PLATE I.

Fig. 1. Old Fortification or Camp, Town 135 N., Range, 34 W., about sec. 27.

Surveyed in 1869, by O. E. Garrison.

Fig. 2. Diagram of Pokegama Falls, in plan (A.) and section (B.) The numbers in "B" refer to samples of rock transmitted with the report.

O. E. Garrison, 1880.

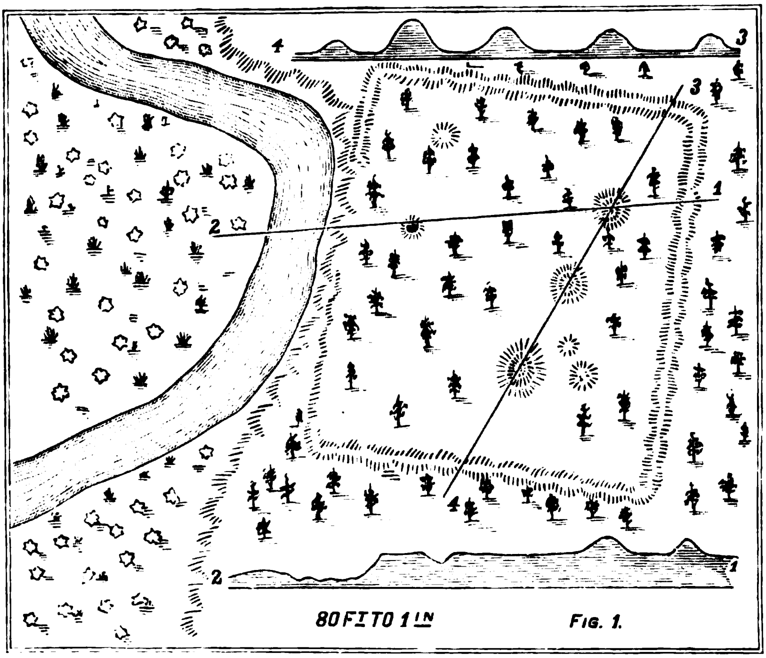


Fig. 1.

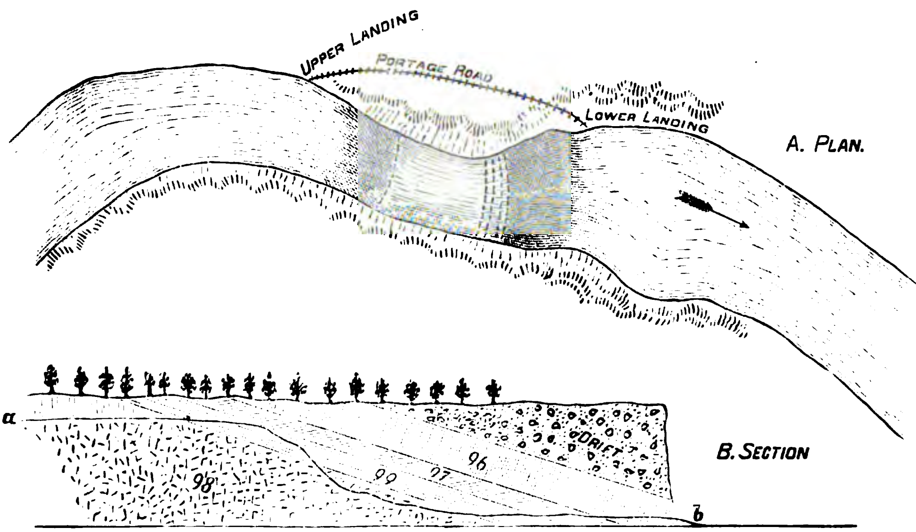


Fig. 2.— Pokegama Falls.

PLATE I.

PLATE II.

Fig. 1. Prairie River Falls. Town 56 N., Range 25 W., 4th Mer.

Fig. 2. Section below the mouth of the Prairie River on the bluffs of the Mississippi. 1. Sandy loam. 2. Pebbles and small boulders. 3. Light colored fine sand. 4. Yellowish sand banded with reddish layers and river mud, and having springs of water. 5 and 6. Red and blue clays. 7. Boulder clay.

Fig. 3. Bed of stratified clay shown in section of the bluff of the Mississippi below the mouth of Sandy River. (a.) unstratified clay; (b.) stratified and jointed clay; (c.) like Fig. 2.; 1 and 2, surface of water in river.

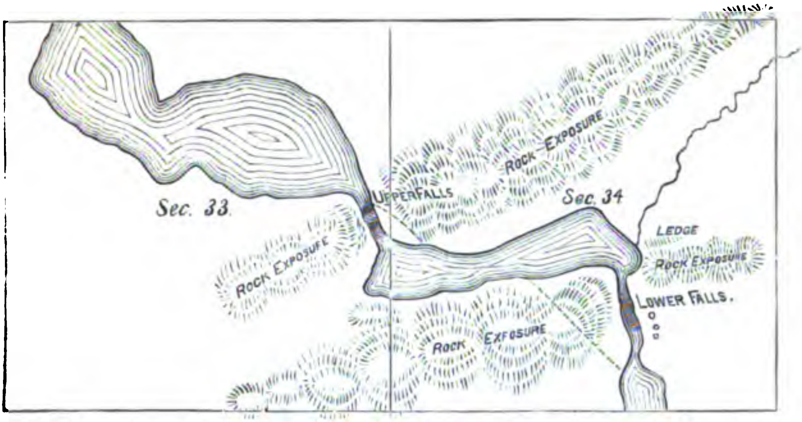


FIG. 1.

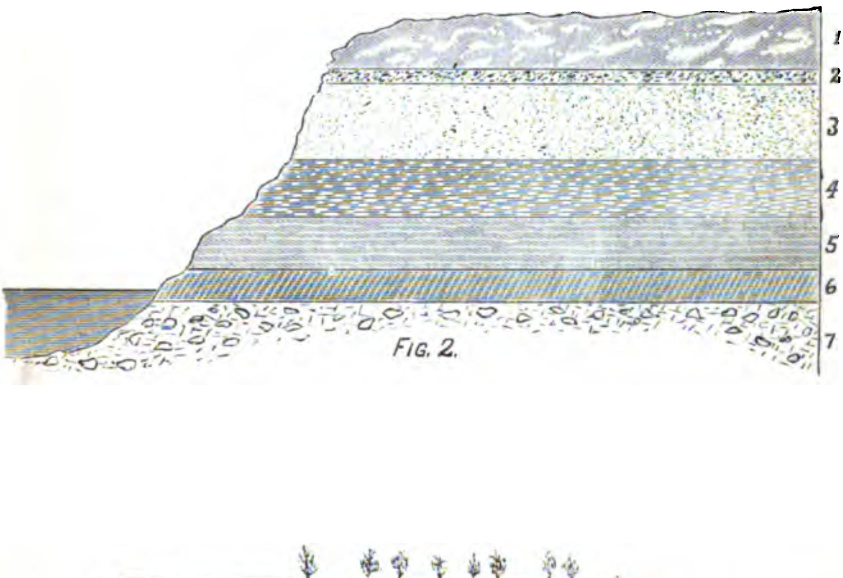


FIG. 2.

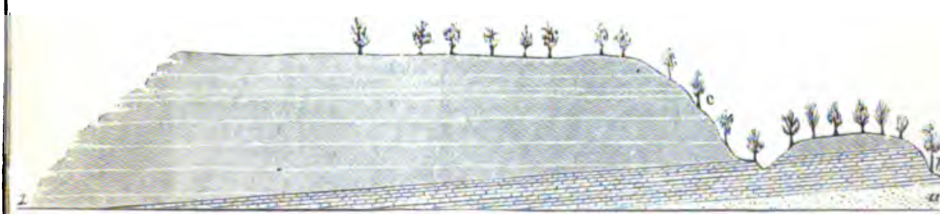


FIG. 3.

PLATE II.

PLATE III.

Sections across the Mississippi and Minnesota valleys:

No. 1. Transverse section of the Minnesota valley at Big Stone lake.

No. 2. Transverse section of the Minnesota near Mankato.

No. 3. Transverse section of the Minnesota at Fort Snelling.

No. 4. Transverse section of the Mississippi valley below Fort Snelling.

Numbers in the vertical scale show heights above the sea.—*[From Warren's Report on Bridging the Mississippi.]*

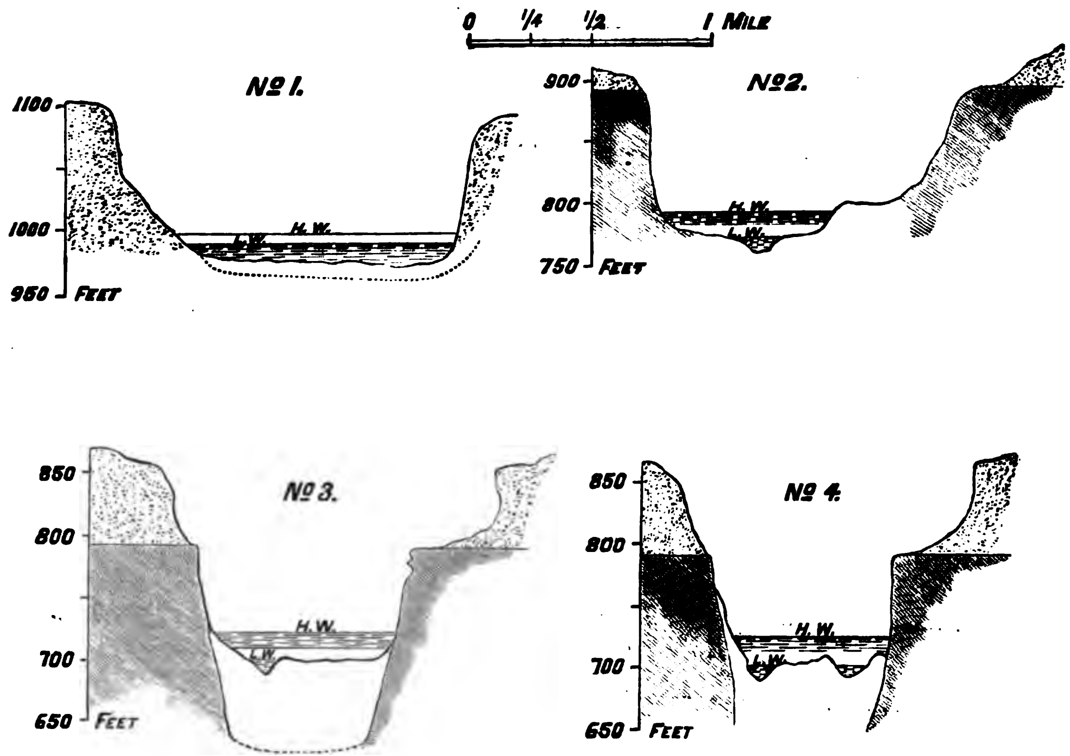

0 1/4 1/2 1 MILE
Nº 1.
1100
1000
950
FEET
H.W.
L.W.
Nº 2.
900
800
750
FEET
H.W.
L.W.
Nº 3.
850
800
700
650
FEET
H.W.
L.W.
Nº 4.
850
800
700
650
FEET
H.W.
L.W.

PLATE III.

PLATE IV.

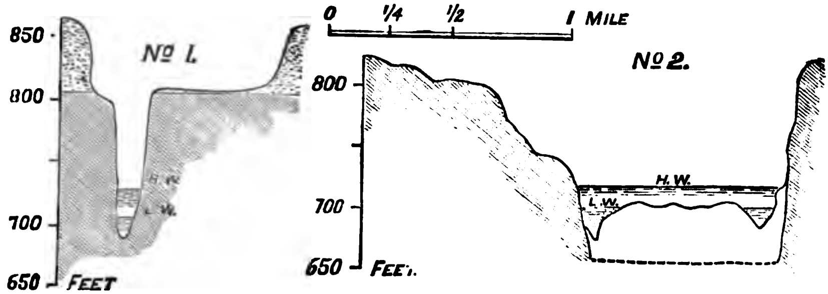
Sections across the Mississippi and Minnesota valleys:

No. 1. Transverse section of the Mississippi valley above Fort Snelling.

No. 2. Transverse section of the Mississippi valley at Hastings.

No. 3. Transverse section of the Mississippi valley at Lake Pepin.

Numbers in the vertical scale show heights above the sea.—*[From Warren's Report on Bridging the Mississippi.]*



850
800
700
650
FEET
Nº 1.
H.W.
L.W.
0
1/4
1/2
1 MILE
Nº 2.
800
700
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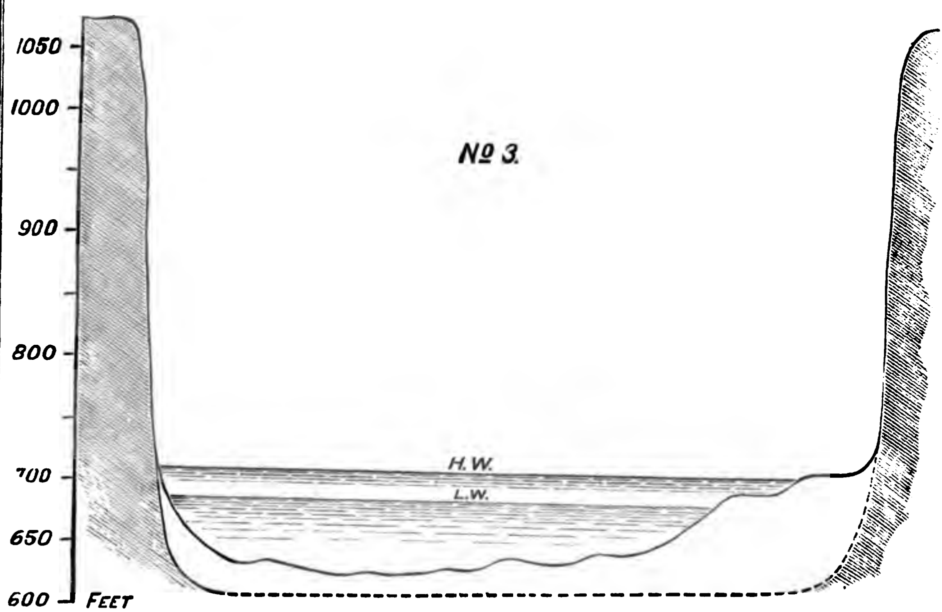
H.W.
L.W.



1050
1000
900
800
700
650
600
FEET
Nº 3.
H.W.
L.W.

PLATE IV.

PLATE V.

The upper Mississippi region reduced from a map by O. E. Garrison:

Explanation.

a. Line north and east of which the characteristic tree is the white pine.—*P. Strobus.*

b. Line including a region in which the characteristic tree is the white pine.—*P. Strobus.*

c. Line including a region in which the characteristic tree is the black pine.—*P. Banksiana.*

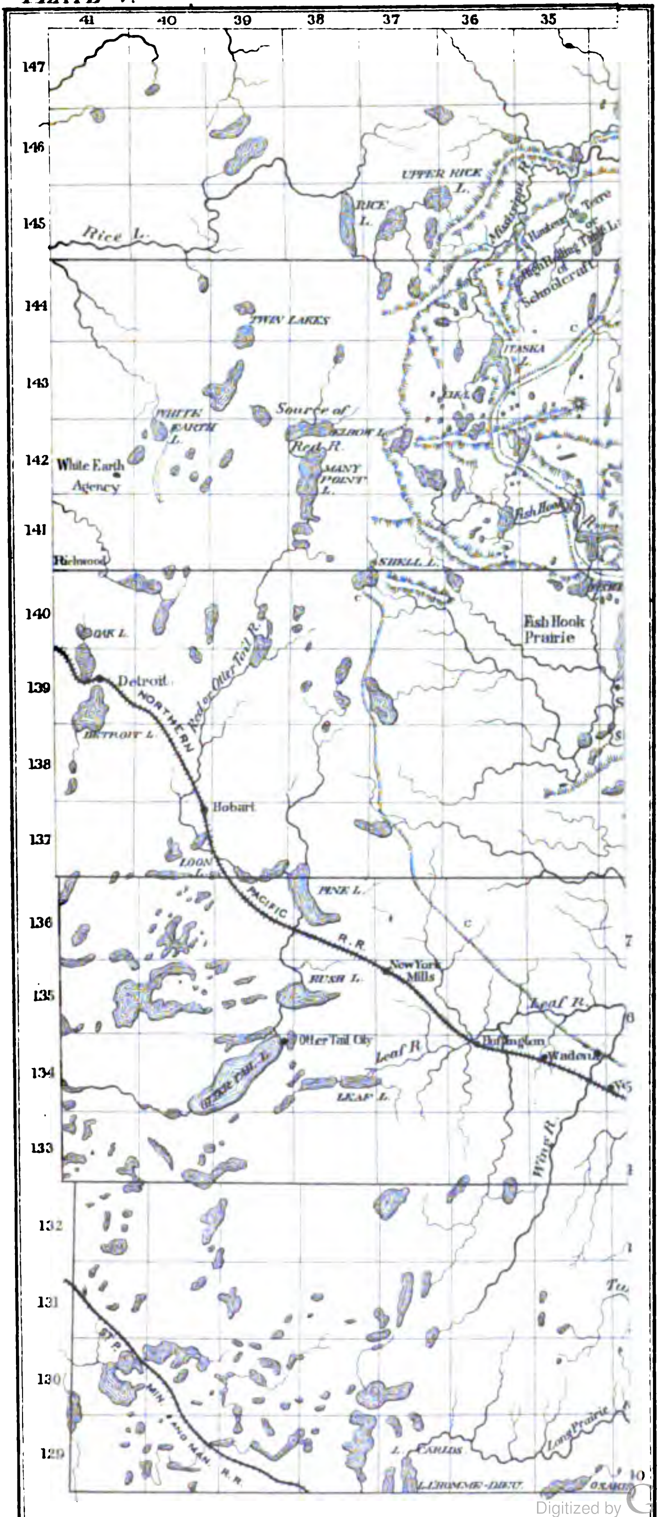
d. Line surrounding a tract in which the characteristic tree is the white cedar.—*Thuja occidentalis.*

‖. Granite outcrops.

= Sandstone outcrops.

The usual symbol represents hills and bluffs.

PLATE V.



41
40
39
38
37
36
35
147
146
145
144
143
142
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137
136
135
134
133
132
131
130
129
Rice L.
UPPER RICE L.
RICE L.
TWIN LAKES
Source of Red R.
ELBOW L.
MANY POINT L.
WHITE EARTH L.
White Earth Agency
Richwood
ITASKA L.
SHELL L.
Fish Hook Prairie
OAK L.
Detroit
DETROIT L.
NORTHERN PACIFIC R. R.
Red or Otter Tail R.
Hobart
LOON L.
PINE L.
New York Mills
RUSH L.
Otter Tail City
OTTER TAIL L.
Leaf R.
LEAF L.
Wadena
Wing R.
ST. P. MIN. AND MAN. R. R.
Long Prairie R.
L. CARLOS
L'HOMME-DIEU

PLATE VI.

The course of the Terminal Moraines, by Warren Upham.

Fig. 1. *Explanation.* Terminal and Medial Moraines are indicated by dotted belts; parallel oblique lines mark the Driftless Area; and dotted lines and arrows show the direction of Glacial currents.

Fig. 2. Map of the region of Lakes Benton, Shaokatan and Hendricks. *Explanation.* Terminal Moraine and Glacial Currents are indicated as in Figure 1. The ridge of the moraine is intersected by remarkable channels which extend southwestward from these lakes.

Fig. 3. Section across the Coteau des Prairies in Yellow Medicine county, Minnesota, and Deuel and Codington counties, Dakota.

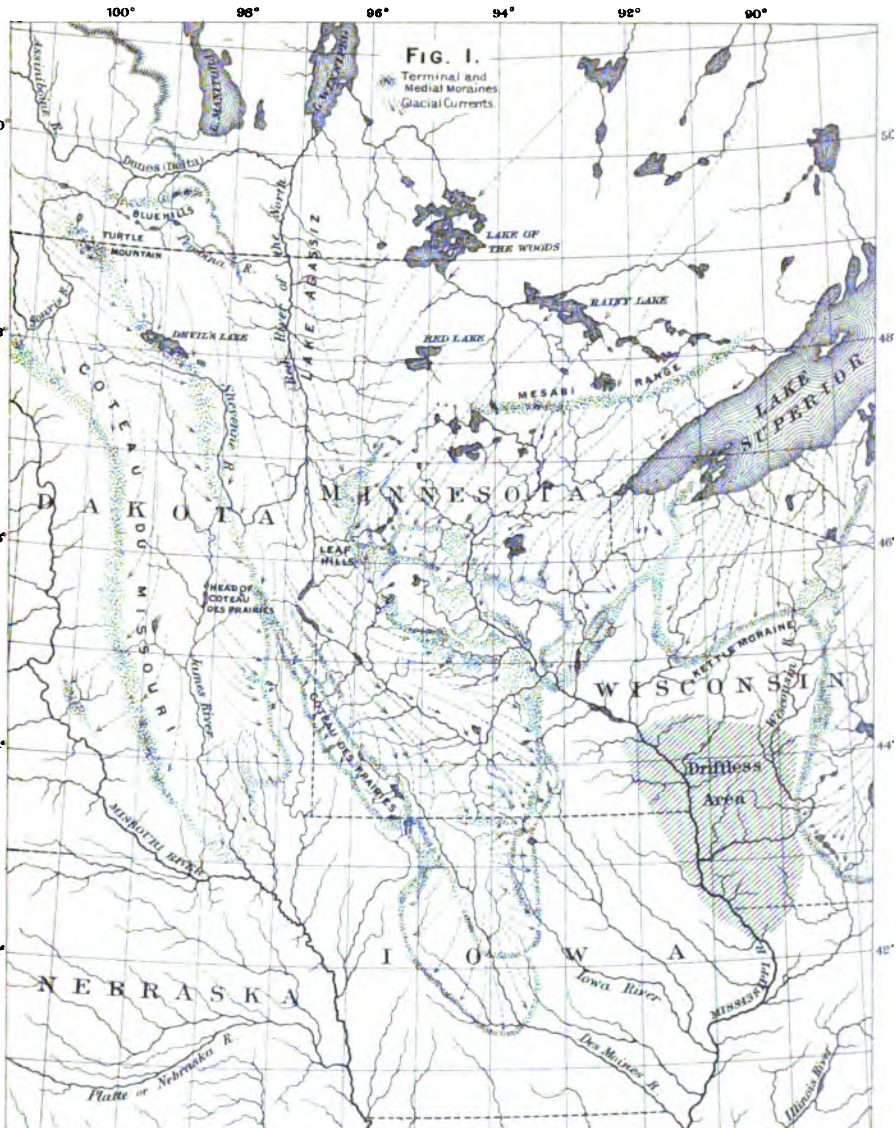
FIG. 1.
Terminal and Medial Moraines
Glacial Currents
100°
98°
96°
94°
92°
90°
50°
48°
46°
44°
42°
23°
21°
19°
17°
15°
13°
Assiniboine R.
L. MANITOBA
L. WINNIPEG
Dunes (Delta)
BLUE HILLS
TURTLE MOUNTAIN
Pembina R.
Red River of the North
LAKE AGASSIZ
LAKE OF THE WOODS
RAINY LAKE
RED LAKE
Souris R.
DEVIL'S LAKE
MESABI RANGE
LAKE SUPERIOR
COTEAU DU MISSOURI
Sheyenne R.
DAKOTA
MINNESOTA
LEAF HILLS
HEAD OF COTEAU DES PRAIRIES
James River
COTEAU DES PRAIRIES
KETTLE MORAINE
WISCONSIN
Wisconsin R.
Driftless Area
MISSOURI RIVER
IOWA
NEBRASKA
Iowa River
Mississippi R.
Des Moines R.
Platte or Nebraska R.
Illinois River

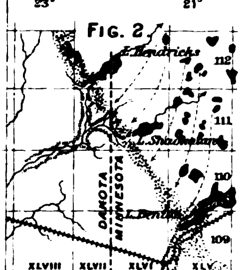
FIG. 2
L. Hendricks
L. Shaokatan
L. Benton
DAKOTA
MINNESOTA
112
111
110
109
XLVIII
XLVII
XLVI
XLV

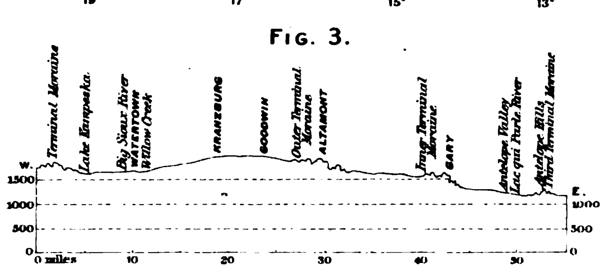
FIG. 3.
Terminal Moraine
Lake Kampeska
Big Sioux River
WATERTOWN
Willow Creek
KRANZBURG
GOODWIN
Outer Terminal Moraine
ALTAMONT
Inner Terminal Moraine
GARY
Antelope Valley
Lac qui Parle River
Antelope Hills
Third Terminal Moraine
W.
E.
1500
1000
500
0
0 miles
10
20
30
40
50